JUN 8 1945

The SCIENTIFIC MONTHLY

PERIODICAL ROOM
GENERAL LIBRARY
UNIV. OF MICH

June 1945

CONTENTS

The River Is the Plow	*E. C. Higbee*	405
Cartography	*A. K. Lobeck*	417
Some Insect Infants	*Alvah Peterson*	426
The Problems We Face in Nutrition	*Frank G. Boudreau*	443
The Rh Blood Factor	*Herluf H. Strandskov*	451
Good Water and Human Longevity	*W. S. Mahlie*	455
Electronics	*John Mills*	459
It Might Have Been Banksia	*Emily Eveleth Snyder*	464
Science on the March		467
Book Reviews		473
Comments and Criticisms		479
Index		481
Meet the Authors		iii

PUBLISHED BY THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
Smithsonian Institution Building, Washington 25, D. C.

The Mineralogical Society of America

Founded twenty-five years ago for the purpose of advancing mineralogy, crystallography and allied sciences. From a beginning of 28 members the Society has grown to a membership (all classes) of over 1000.

There are four classes of membership: Correspondents, fellows, members and subscribers. Correspondents are distinguished scientists not resident in North America elected by the Council. Fellows are those who have a substantial record of scientific publication or noteworthy mineralogical achievement in other ways. Members are those engaged or interested in mineralogical work and include not only younger mineralogists but mineral collectors and scientists in related fields. The membership fee is $3.00 per year and entitles the member to *The American Mineralogist*, the monthly publication of the Society. Subscribers are those institutions, libraries, and laboratories who purchase the journal of the Society.

Any one wishing to become a member of the Society should communicate with:

C. S. HURLBUT, JR., *Secretary*,
Harvard University,
Cambridge 38, Massachusetts

American Veterinary Medical Association
Organized in 1863

Purposes: To advance the science and art of veterinary medicine, including their relationship to the public health.

Membership: Active membership limited to graduates of accredited colleges of veterinary medicine. Entrance fee $5.00 plus annual dues of $7.00 which includes subscription to official monthly Association publication. (see below) Honorary membership is conferred on a limited number of individuals who have contributed distinguished service to veterinary science or to advancement of its application.

Publications: (1) Journal of the American Veterinary Medical Association (monthly); established 1877. Free to members, subscription price to non-members $7.00, Canadian and Foreign, $8.00.

(2) American Journal of Veterinary Research (quarterly); established 1940. Price, $2.50 to members; $4.00 to non-members and in Canada and countries in the Pan-American Postal Union; $4.30 foreign.

DR. J. G. HARDENBERGH,
Executive Secretary,
600 S. Michigan Avenue,
Chicago 5, Illinois

SIGMA DELTA EPSILON
Graduate Women's Scientific Fraternity

¶ Sigma Delta Epsilon was established on May 24, 1921 at Cornell University by a group of graduate women in science. It became a national organization in 1922. There are now fourteen chapters including an alumnae chapter for women scientists who do not live in the vicinity of a local chapter.

¶ The object is to further interest in science, to provide a society for recognition of women in science, and to bring them together in fraternal relationship. From a trust fund established in 1926, two fellowships for scientific research have been granted—one in 1941–42 and one in 1943–44.

¶ A Newsletter containing information about the national organization as well as the local chapters is published twice a year. The national convention is held in connection with the meetings of the American Association for the Advancement of Science.

DR. MARY L. WILLARD,
National President,
Pennsylvania State College,
State College, Pa.

DR. LELA V. BARTON,
National Secretary,
1086 North Broadway,
Yonkers 3, N. Y.

THE SCIENTIFIC MONTHLY

JUNE, 1945

THE RIVER IS THE PLOW

By E. C. HIGBEE

EVER since its discovery 400 years ago, the future prospects of the Amazon Valley have been the subject of lively armchair speculation. The fact that comparatively little progress has been made in all that time has not sobered the Amazon's drawing-room enthusiasts. The vastness of its area, roughly equal to that of the United States, perhaps accounts for a persisting popular interest. There has been a feeling that so much space must contain something valuable and should produce more than weird legends about head-hunting Indians. It does—but chiefly in the form of jungle products which are hard to obtain.

Perhaps the most noteworthy contribution the Amazon has yet made to the world has been a group of native economic plants, including rubber and quinine, which have been transplanted to other parts of the globe where they are more efficiently produced on plantations. There is reason to believe it has further important contributions to make. Within recent years it has given the world the Lonchocarpus plant, an excellent source of the insecticide rotenone. In all probability time and explorations will extract others from the prolific Amazon storehouse.

The jungles of the Amazon, happy hunting grounds of the tropical botanist, are a forester's nightmare. Here one finds stands of mixed species of which only a small proportion are economically important. The value of the products in most cases will not pay for their commercial salvage. This situation is becoming more pronounced as the accessible lands along the river's edges are utilized.

The Amazon Basin remains one of the world's most primitive and unproductive regions for many reasons, and not the least of these is the fact that the majority of its population is primarily occupied with the details of subsistence living rather than with the harvesting and processing of jungle products. They have neither the time nor the inclination to produce great quantities of goods for export. This preference for self-sufficiency is not entirely voluntary. No one is more delighted with the articles of the industrial world than are the people living here. To indulge their desires, however, even in a moderate manner, is beyond their earning power; and so they accept the alternative and each family spends most of its time taking care of its own needs, in so far as possible, by using the crude resources of the forests instead of laboring for the streamlined products of industry. Wild game and fish, together with wild fruits, nuts, palm hearts, and other vegetable products obtained from the forests, provide a substantial share of the daily diet.

While the average Amazon family obtains much of its food from the wild, it is obliged to supplement nature's abundance with a few staples produced at home. The principal items are manioc, rice, beans, corn, bananas, plantains, papayas, oranges, pineapples, chickens, and eggs. The chickens shift for themselves almost entirely by subsisting on insects, weed seeds, and wild greens, supplemented by a little household refuse. An enterprising missionary I knew in Pucalpa, Peru, hunts alligators to make a dehydrated protein supplement of their entire carcasses for his chickens. He also feeds grain with the result that his hens have made an excellent laying record, but his example has not been followed because the natives are not

TYPICAL RIVER-BANK DWELLER'S HOUSE. LOWER BRAZILIAN AMAZON

enthusiastic about the extra work it entails.

Throughout the valley practically all communication is by water. The principal overland trails through the forests are the shortest distances between rivers. They correspond to the portages formerly established by the Indians of the Great Lakes region of the United States. The dugout canoe is a symbol of Amazon life. This crude craft, hollowed from the trunk of a large tree—frequently a mahogany or Spanish cedar is usually 12 to 15 feet long, although some as large as 30 feet in length and 4 feet wide are made for merchants and landowners to haul their goods. In the Lower Amazon, particularly in the Bay of Marajó, sailboats are common carriers of merchandise, while in the headwaters region of Peru balsa-log rafts transport produce downstream. A considerable proportion of the produce brought into the port of Iquitos arrives on balsa rafts which are usually equipped with a palm-leaf shelter for the crew who sleep and cook their meals aboard. A journey on a raft, which in some cases may last a week or two, is seldom interrupted by tying to the river bank until the destination is reached. These rafts keep to the mid-channel as well as possible to avoid snagging on submerged logs near the shores and to escape the dangers of being crashed against the river banks by the swirling whirlpools of the stream. At night the crews put up signal lanterns to warn steamboats of their presence, since they are not easily maneuvered. Frequently a steamboat is obliged to idle its engines when passing these craft to avoid swamping them.

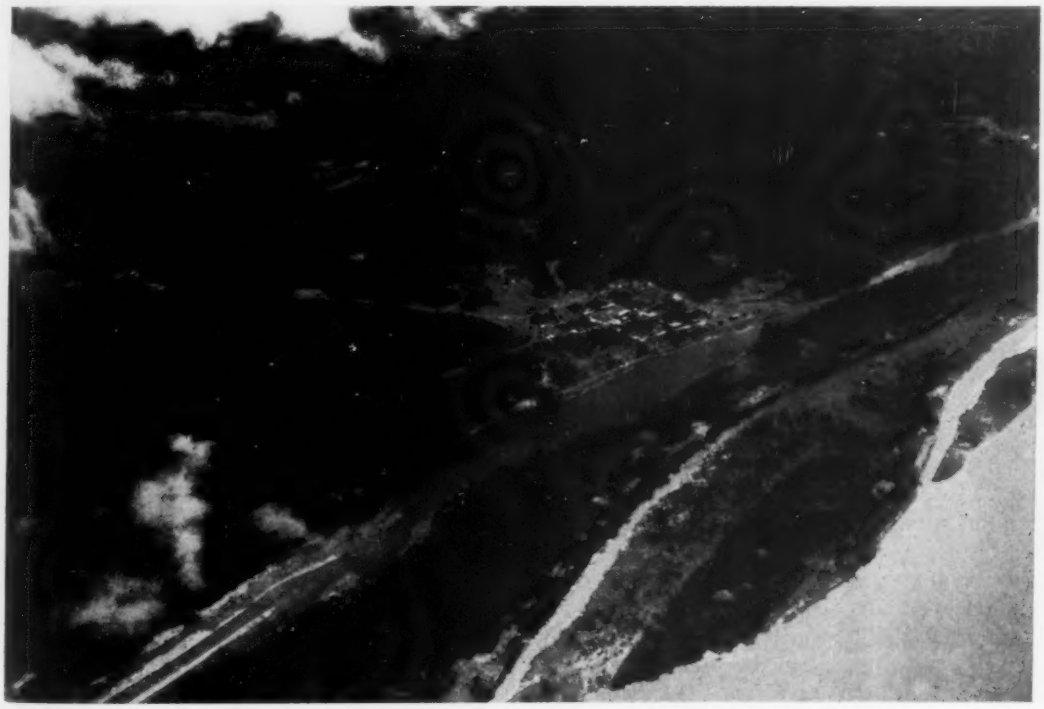
The steamboats themselves are practically all wood burners, which are obliged to make frequent stops along the river banks to pick up fuel. Providing wood for these boats is a source of income for any bank dweller along the main streams who has the industry to cut the trees and split the cordwood, which is stacked in measured cubic-meter squares along the shores in full view of passing boats to excite their interest. Traveling on these boats, which are itinerant markets whose clerks comprise the passengers and crew, is one of the best means of observing the nature of Amazon trade and the produce of the

regions one travels through. Air travel is more comfortable and dignified, but unless one has journeyed on the river by steamboat, raft, or canoe and lived for a time in the mud-pathed villages of palm-thatch huts along the way, he will never have known the details of Amazon life, which are not so greatly different today from what was simply yet so faithfully described by Alfred Russel Wallace in his travels nearly 100 years ago.

Canoe travel is one of the most characteristic pastimes of the Amazon native. He is a natural busybody. He loves gossip, particularly if he can tell the tale. Not having newspapers, radios, or telephones, the people nevertheless keep remarkably well informed about one another's activities, within certain regional limits, via the river "grapevine." The native's principal recreation is associating with his friends. He thoroughly enjoys conversation, dancing, and drinking with his companions. To provide himself with these simple prerequisites for pleasure requires no contact with the outside world. The rivers being the thoroughfares of communication, those who are paddling up and down in their canoes are in the very whirl of social activity. Much of this roaming is associated with a little business of a barter nature. A family may have a few extra dried fish or a surplus basket of manioc, the monetary value of which could be reckoned in a modest amount of small change, but it provides an excuse for getting around and seeing things. In passing one another in canoes they do not have much time for repartee, but everyone makes the most of it by calling out greetings in a direct and inquisitive manner, as typified by the following river verse:

¿ Como se llama?
¿ Como está?
¿ De dónde viene?
¿ A dónde va?

What is your name?
How are you?
Where do you come from?
Where do you go?



VILLAGE OF NAUTA ON THE MARAÑÓN RIVER IN PERU

PERMANENT BARRIER IN FRONT OF THE CITY WAS BUILT UP BY A SUCCESSION OF "PLAYAS." LARGE STEAMERS CAN NO LONGER REACH THE VILLAGE AND MUST PASS BY IN THE MAIN CHANNEL (LOWER RIGHT-HAND CORNER).

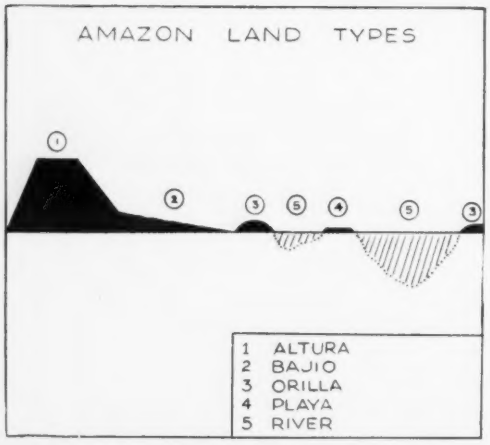


DIAGRAM OF AMAZON LAND TYPES

If there were a few more lines they would run in the same vein: Why are you going? What have you to eat? How many babies do you have? Homely information of this sort gathered in a day's time will serve for long evenings of conversation and much speculation.

It is difficult to give a concise description of the Amazon lowlands, which constitute the great central area of the basin. A view from the cabin of an airplane of the monotonous immensity of the broad valley floor tests one's credulity. To be sure, the apparently flat earth below is terra firma, but it is a world practically without evidence of man's existence. It is an endlessness of mossy green thinly flecked with the purple, yellow, and pink of flowering trees sometimes dissected by the serpentine meanderings of an occasional river. The feeble perforations made by men who have hacked out isolated clearings here and there near the edges of the streams for a house, a garden, or a village are scarcely distinguishable until one is almost over them. The variations in the pattern of jungle vegetation, apparently determined by the drainage characteristics of the topography, offer the only contrasts. Concentration is required to observe all but the most obvious of these, such as the scattered areas of grasslands and the young forests which have invaded the former channels of rivers. In all this vastness there are only three large cities, Belém and Manáos, in Brazil, and Iquitos, in Peru. They are as widely separated as New York, Chicago, and Denver.

Viewed from the intimate range of a paddler in a dugout canoe, the picture is quite different. There is a surprising amount of human activity. The slower one travels the more apparent this activity becomes. One's view of the world is restricted to the river and to its banks. It is along the banks that people have settled, and it is near the banks that the Indians have always lived. The explanation is simple. People must move about to find game food and exchangeable products in the forest, to catch fish in the streams, and to communicate with one another. The only practical way to move and to transport their goods is by water. The vast expanses of jungle which lie far inland from the rivers are practically uninhabited. The people of the Amazon Basin may be correctly described as bank dwellers.

The topography of most of the central area of the Amazon Basin, which lies within the fall line of its rocky rim, is in reality gently undulated, although it appears to be almost

MAKING A VERY SMALL CANOE

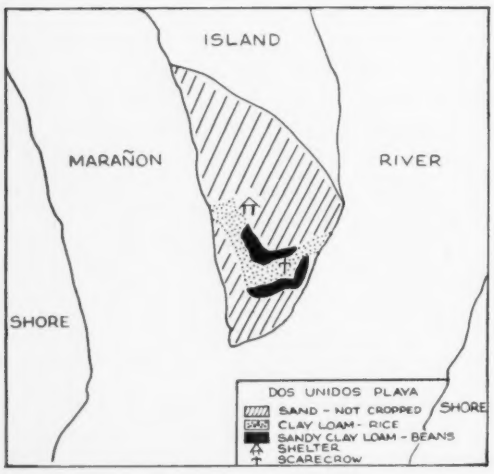
flat from the air. The rolling surface of the land may be compared to an immense washboard. At the peak of the rainy season the depressions of the corrugated earth are gradually flooded while the ridges remain above water. Almost all villages are built on highland, but thousands of individual squatters have chosen to settle in the low spots.

People who have built their huts along the river banks in the low areas find the water level reaching to the doorsteps of their stilt-supported houses at flood time. Fortunately this critical period, which comes regularly at the end of the annual rainy season, lasts only a few weeks. The rising of the water produces a paralyzing effect such as does the accumulation of snowdrifts on the farmlands of our northern states; at such times activity, except for the passing of canoes over the flooded territory, is practically at a standstill. These floods destroy comparatively little property, for the waters pass under the stilt-supported houses, seldom undermining them. Even when an occasional house may be destroyed the loss is not disastrous. It is merely a matter of a few weeks' work to build another out of local materials: posts and matted palm leaves tied together with jungle vines. Seldom is human life endangered, for as the waters spread over the banks and the lands beyond, the force of the current is dissipated until it is scarcely noticeable. Under the trees and about the huts it is almost motionless.

The floods may be of more benefit than harm, for the waters of the Amazon and of its tributaries are heavily laden with silt, which is deposited over the little clearings around the bank dwellers' huts. These deposits will range in thickness from a few inches to a foot or more in one season's flood. When the water subsides, manioc, beans, corn, and rice may be planted in this mud, which is more productive than the soils of the highlands. This is one reason the lowland areas are desirable home sites.

ALTURA LAND CLEARED FOR PLANTING

Generally speaking, the broad territory lying within the fall-line rim of the Amazon Basin may be divided into four classes. In Spanish they are known as the "alturas," the "bajíos," the "orillas," and the "playas." The *alturas* are the highlands seldom extending over 200 feet above the



A *PLAYA* LAND-UTILIZATION PATTERN

flood levels of the rivers. The *bajíos* are the lowlands which are flooded in the rainy season. In some cases they remain permanently swampy. The *orillas* and the *playas* are associated only with the river channels. The *orillas* are levee-like river banks, while the *playas* are sedimentary bars laid down in and along the river channels each summer when the rains slacken and the river waters recede. The accompanying diagrammatic cross section shows a common relationship of these land types.

The *alturas* are covered by forest growth. The predominant vegetative cover of the *bajíos* and the *orillas* is the forest; occasionally grass. The *playas* are barren of plant life when they first appear, as they are fresh sedimentary deposits composed of various mixtures of sand, silt, and clay. The size, shape, and even the position of these sedimentary bars may change from year to year. On the *alturas*, or the highlands, soil fertility is soon exhausted, and after a few seasons the plots prepared for gardens must be abandoned and new ones cleared. On the *bajíos* and the *orillas*, where alluvial mud is deposited by the winter floods that restore fertility and smother out weeds, cropping goes on indefinitely. The *playas* are suitable only for such crops as rice and beans, which may be planted and harvested within a four- to five-month period between June and November, when river levels are low. On the *playas* no land preparation whatever is necessary, for as soon as the flood waters subside the alluvial deposits are ready for planting. The river is the plow and the harrow in this region where draft animals and tillage implements are practically unknown. It is a seeming paradox that here where Nature herself prepares the farmer's seedbed each year there is only a feeble popular interest in agriculture. The answer perhaps lies in the fact that the forests provide even more easily obtainable produce.

Another reason for not growing much more food than is necessary for one's own subsistence is that if there is a surplus it will have little exchange value. There may be a near-famine in a large city, such as there was in Iquitos in 1943 when I was there. Yet several days' journey beyond that city the prices offered by river merchants traveling in their steamboats were but one-seventh

PLANTING MANIOC CUTTINGS
IN ALLUVIAL MUD ON AN ORILLA JUST AFTER THE RAINY-SEASON FLOOD. MARAÑÓN RIVER, PERU, 1943.

to one-half of the current retail values in Iquitos. The farther the boats were from Iquitos the less was offered for the food. Any attempt to stimulate increased food production in the Amazon is likely to evoke considerable enthusiasm in Belém, Manáos, or Iquitos, where people are frequently without adequate rations, but it is not likely to make much of an impression on the bank-dwelling natives who would be expected to put in the crops. Chinese and Japanese gardeners who painstakingly tend little vegetable plots in and around the large cities have the answer to profitable food production in the Amazon. Their genius for doing the hard work necessary to conserve and compost organic matter, to carry water to the plants when they require it, combined with their shrewd business judgment in growing their crops where they can market them directly, has made them successful. These Orientals, however, are products of an agricultural tradition, while the Amazon native is more skillful in exploiting the forests; and so it is only natural that each should seek to follow the pursuits in which he excels.

Only the choicest of lands on the *playas* are chosen for cropping. These are the clay loam and sandy clay loam areas which are irregular depressions or beds of drainage channels developed in the process of the *playa* formation. The true sand areas, which constitute most of the *playa*, are not planted to any crops. These sand areas are deposited by the more rapidly moving river currents in the early stage of the bar formation. A *playa* visited on the Marañón River near the little village of Dos Unidos, Peru, in 1943 had the land-utilization pattern shown in the accompanying figure.

The main part of the island shown in the diagram had not been flooded. The area where the sedimentary deposit was laid down off the point of the island had been under water throughout the rainy season, a period of about seven months. As the river level dropped during the latter part of June the configuration and the contours of the *playa* became outlined. About the first of July, as the low areas began to drain, the sandy-clay loam formations started to appear and the beans were promptly planted. The seeds were dropped into small holes punched with the point of a stick, then closed over with a light covering of soil by a scuff of the planters' feet. About a week later channels of the drainage way were free of water and the ground, although very soft, could be traversed by the planters who slogged in mud up to the calves of their legs to broadcast rice seed by hand. The river dwellers who plant rice and beans on the *playas* are expert judges of soil composition, for hardly a seed is wasted on unproductive sand areas. Birds constitute a plague to broadcast rice until it is well established and again from the time it heads until harvest. To ward off the attack of these winged culprits women and children watch the fields to disperse them with shouts and noisemakers whenever they threaten to alight. Scarecrows, too, are sometimes employed, but with little success.

Where turtles are numerous their eggs are

PLAYA FORMATION AT IQUITOS, PERU: AUGUST 1943

THIS PLAYA IS SITUATED AT THE HEAD OF THE ISLAND ACROSS THE MAIN AMAZON CHANNEL, DIRECTLY IN FRONT OF THE CITY. NO CROPS ARE PLANTED ON THIS PLAYA BECAUSE OF ITS PROXIMITY TO THE CITY.

AMAZON RIVER *PLAYA* NEAR IQUITOS, PERU

THE RICE HERE IS PLANTED IN HOLES MADE WITH A STICK IN THE LOW CLAY-LOAM DEPOSIT OF THE PLAYA.

found in deposits of up to a hundred or more buried in the sands of the *playas* where they have been left to incubate. At night, by the light of flares and lanterns, people hunt the turtles which come ashore to lay their eggs. The turtles are flipped over on their backs where they helplessly paddle the air with their feet until they are collected after the hunt. Large ones may weigh as much as 100 pounds.

The *playas* are not always advantageous by any means. Aside from the fact that many an Amazon steamboat has been temporarily grounded by the formation of one in a previously open channel, they sometimes block off access to the mud banks in front of villages where the boats are accustomed to tie up. Perhaps Iquitos would not be the only large city in the upper Amazon today if such a sedimentary bar had not formed in front of the village of Nauta on the Marañón River toward the end of the last century. At that time Nauta, a relatively thriving city, was the principal competitor of Iquitos. The *playa* was never washed away; in fact it became a permanent island which grew larger year by year and effectively cut off the water approaches to the city which had previously accommodated large boats. Today Nauta is a village of but some 400 families where grass and the jungle compete for dominance of abandoned yards and gardens.

The fortune of many an Amazon village has been altered by the capricious currents of the rivers which during high-water stages may rip out long strips of bank and destroy the villages piecemeal over a period of years. Little or no effort is made to check this erosion of the stream banks or to dredge out the *playas*, since the means required to control the rivers would be more costly than the villages could afford. It is cheaper and easier for the inhabitants to migrate and build new huts. The remnants of huge trees and "islands" of floating grass, which are continually floating down the Amazon to the sea and which seldom fail to make a lasting impression on the minds of those who have traveled on that river, are testimony of this continual destruction. The most obvious evidence, however, is the brown silt-laden water of the stream.

In itself land is not regarded as having much value. When property holders, or *patróns* as they are known in Peru, and as *donos* in Brazil, realistically discuss the

worth of a tract or a concession, they say it has so many squatters or peons. They base estimates of their probable income on the number of families living on their property and not on the acres under their control. I have known people holding title to thousands of acres who derive no income from them for the reason that they do not work the land themselves and there are no peons squatting on it who might be expected to work for them. The pattern of land ownership in the Amazon Basin, derived from Spanish and Portuguese colonial policy, is similar to that found in other regions of Latin America. Large tracts are owned by governments, companies, and a small percentage of influential individuals, while the majority of the people, having no land of their own, worthless as it is, are obliged to work on that of the *patróns*. The *patrón* welcomes these squatters or peons. Some charge rent for the privilege of squatting, while others do not in order to encourage settlement. What is of more importance to the *patrón* than rent is the fact that the peons on his land constitute an available supply of labor which he can hire in repayment for goods he sells to them. The peon usually prefers to work in the forest gathering jungle products, but there are exceptions to this rule.

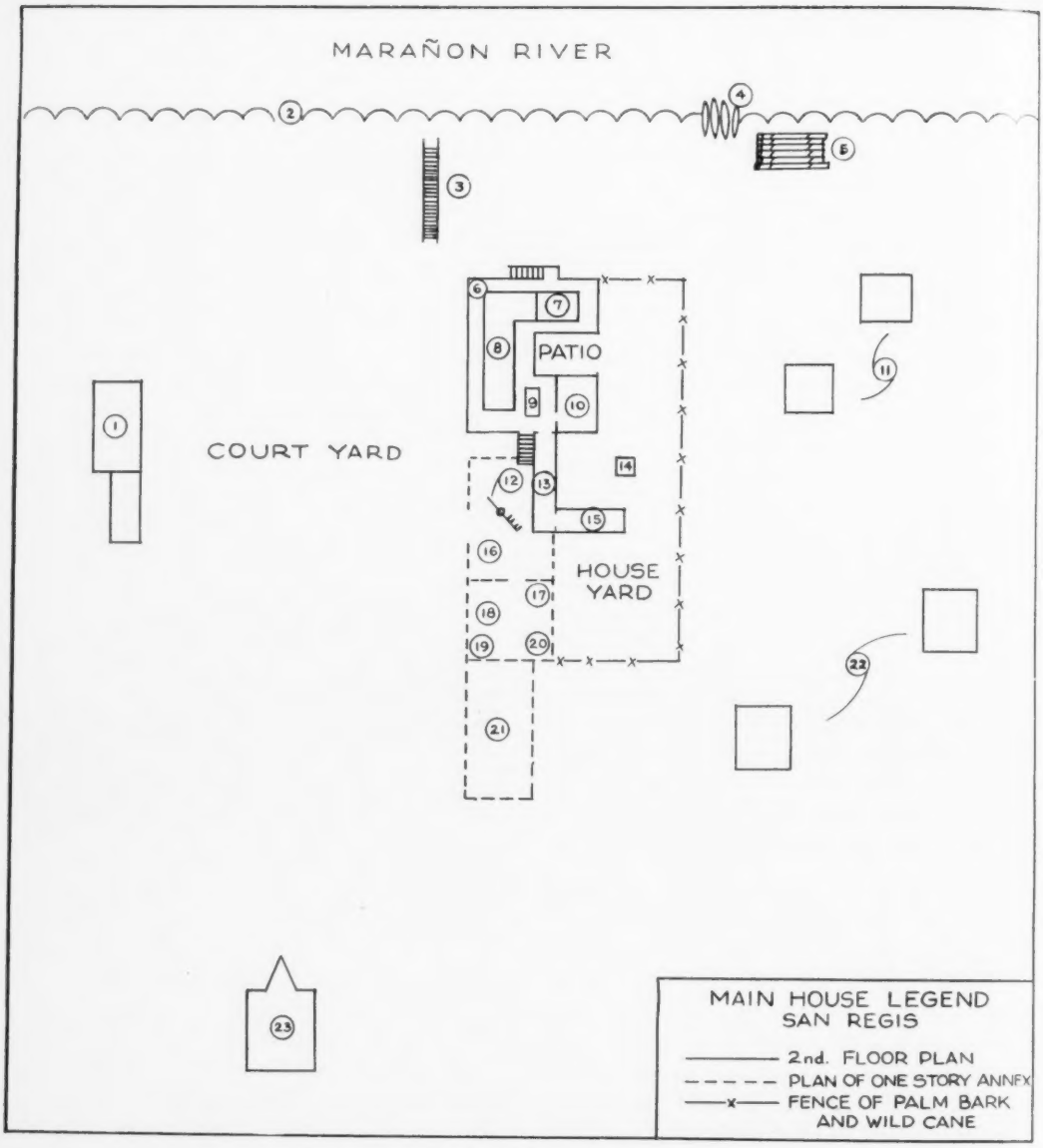
For instance, during the past ten years considerable interest has developed in producing Lonchocarpus roots in some parts of the Peruvian Amazon. These rotenone-containing roots are now the most important single export item passing through the port of Iquitos. Also, during recent years, jute cultivation has become popular in certain sections of the Lower Amazon in Brazil, chiefly through the efforts of Japanese settlers. Most of the acreage sown to these crops is financed by the traditional advance system whereby the *patróns* and mechants make loans to the growers, who repay with the produce they raise. Usually the advances are made in installments: a certain sum when the land is prepared, another when it is planted, and so on until it is harvested and accepted by the creditor in payment of the indebtedness.

The following represents a pattern of how a peon may negotiate with his *patrón:* Perhaps the peon wants a machete, which in 1943 retailed for the equivalent of about $5 in the Amazon Valley. After receiving his machete the peon is under obligation to work off its purchase price in terms of produce or a number of standard tasks of work. In the case of rubber, for instance, a man may be expected to gather and smoke between 3 and 4 pounds of rubber in one day, and that may be considered a task. The money value of such a day's task varies from place to place. In 1943 it ran between 20 and 60 cents a day; so assuming an average of 50 cents, a peon would be expected to work 10 days and gather between 30 and 40 pounds of rubber to pay for the machete.

FLOATING DOCK AT IQUITOS, PERU

BECAUSE THE RIVER LEVEL IS CONTINUALLY FLUCTUATING, THIS TYPE OF DOCK IS NECESSARY. IT VARIED FROM 45 TO 87 FEET HERE IN ONE YEAR.

In 1943 the best grade of rubber was worth 45 cents a pound in Belém on board ship bound for New York. The machete was worth $1 plus ocean freight before it was unloaded from the same ship at Belém. Somewhere in the network of Amazon exchanges a $1 machete became worth in some cases from $13.50 to $18.00 in rubber. The average *patrón* does not make all or even a major part of the difference, since he buys and sells through intermediaries who range from peddlers to large export-import companies. Each product usually passes through many hands, and few Amazon traders are interested in any merchandise which does not involve 50 to 100 per cent profit.



PLAN OF A TYPICAL AMAZON *FONDO*—SAN REGIS VILLAGE

1. OVERSEER'S HOUSE; *2.* RIVER BANK; *3.* STAIRWAY LEADING UP RIVER BANK FROM SHORE; *4.* CANOES; *5.* BALSA RAFT BEACHED BY RECEDING RIVER LEVEL; *6.* VERANDA; *7.* STORE; *8.* LIVING QUARTERS; *9.* DINING TABLE (FROM HERE THE PROGRESS OF WORK IN *16* CAN BE SEEN); *10.* KITCHEN; *11.* HOUSES OF WORKMEN MORE OR LESS REGULARLY EMPLOYED FOR SPECIAL TASKS; *12.* TRAPICHE OR SUGAR CANE, MILL POWERED BY 2 MULES DRIVEN IN A CIRCLE AT END OF BEAM WHICH TURNS THE MILL'S GEARS; *13.* RAMP FROM WHICH WORK IN *16* AS WELL AS ADJOINING ROOM CAN BE SEEN; *14.* CHICKEN HOUSE; *15.* ROOF ON WHICH FISH IS CUT UP AND DRIED; *16.* LARGE SHED FOR STORING AND MILLING SUGAR CANE; *17.* OLD CANOES IN WHICH SUGAR CANE JUICE IS ALLOWED TO FERMENT FOR MAKING RUM; *18.* CALDRONS FOR BOILING DOWN CANE JUICE TO MAKE CRUDE BROWN SUGAR; *19.* LARGE KETTLES FOR TOASTING GRATED MANIOC ROOT INTO A PRODUCT KNOWN AS FARINA; *20.* STILL FOR MAKING RUM FROM FERMENTED CANE JUICE; *21.* SCHOOL; *22.* HOUSES OF SPECIAL WORKMEN; *23.* CHURCH TO WHICH ITINERANT PRIESTS WOULD COME TO CELEBRATE FEAST DAYS. THE FIRST FLOOR OF THE MAIN HOUSE CONSISTED OF STOREROOMS. THE HOUSE WAS "WHITE WASHED" WITH MIXTURES OF WATER AND EARTH. THE RIVER DWELLERS' HOUSES ARE SCATTERED OUTSIDE THE PERIMETER OF THIS UNIT.

Conversely, when a jungle product is offered to a trader by the *patrón* it is accepted only at a low evaluation, because it must pass into export channels through several hands, which means that only a very small fraction of its value can be paid to the credit of the peon who gathers it.

The average *patrón* might be called middle-class even though he may control properties ranging up to several thousands of acres in extent. These middle-class *patróns* usually lack sufficient capital to finance the exploitation of their lands and are obliged to rely on wealthy import-export houses in the large cities for credit.

In July 1943 my wife and I were the guests of Señor Alpio Antuñez, *patrón* of San Regis on the Marañón River in Peru. No one could be more cordially received than he who has the good fortune to be the guest of Señor Antuñez. His house became ours in a very generous manner for the few days we spent with him, while I had the opportunity to visit the Lonchocarpus plantings of several of his peons and to observe the gathering of *leche-caspi*, or "tree milk," which is a chewing-gum latex.

The hacienda, or *fondo*, of Señor Antuñez at San Regis was an example of what I have chosen to call the middle-class type. His landholdings consisted of roughly 30,000 acres, practically all of which were virgin jungle. He did not know exactly how many squatters had erected houses on his property, since they were always coming and going, but he estimated them at 150 families. Typical of peons, they had their plantings of miscellaneous fruits and vegetables. Señor Antuñez kept a store, and his people worked in return for the articles they bought there. He had a few acres of sugar cane from which he made rum under government license as well as crude brown sugar. Each year he planted a small acreage of rice, and his men gathered jungle products from the forest which he sold in Iquitos or to river merchants who stopped their boats at San Regis to do a little trading. Señor Antuñez kept several cows to provide milk for his household. He raised a few hogs for his own table and for sale. A number of chickens in a fenced yard near his house kept him supplied with eggs.

One or two of the peons at San Regis were usually kept occupied with fishing for *paiche*, (*Arapaima gigas*). In Brazil this same fish is known as the *piraracu*. It is the Amazon substitute for dried salted *bacalao*, or cod, which is one of the staple foods of the laboring classes of Latin America. The *paiche*, which is much larger than the cod, is caught with a hand-hurled harpoon. This unusual fish requires atmospheric oxygen, and so it is obliged periodically to rise to the water's surface for a gulp of air. I timed the frequency of the breathing periods of two mature specimens of this

THE "MAKINGS" OF ROTENONE
LONCHOCARPUS ROOTS LOADED IN CANOE AND ON BALSA RAFT AT THE WATERFRONT AT IQUITOS, PERU.

fish in the experimental ponds of the Museo Goeldi at Belém in 1942 and found it to range from 8 to 13 minutes. A fisherman locates the *paiche* by watching for it to break water for air and then hurls his harpoon at the mark. Large ones, I have been told, will weigh up to 150 pounds. While we were at San Regis a fisherman brought in a specimen weighing 55 pounds which he estimated was 3 years old. It was cut up; part was given to the fisherman as a bonus. We ate some, but most of it was salted and dried in the sun for sale.

The arrangement of the rambling house belonging to Señor Antuñez and the activities

which took place under its many roofs bore the unmistakable mark of the Amazon. To discuss all in detail is beyond the scope of this paper, but an imaginative interpretation of the accompanying diagram, which shows the house, courtyard, and general plan of San Regis village, will give the reader a picture of a typical Amazon *fondo*.

Even the largest Amazon landholdings, which run into millions of acres, are broken down into a series of little units on the San Regis pattern.

An understanding of the *patrón*, or *dono* system is essential to any person who is interested in buying products from the Amazon. That rubber exports from this region have been disappointingly low during the war period may be traced in part to a failure to appreciate this fact. In an effort to reach rubber tappers directly a plan was designed to cut out the big import-export merchants by substituting a single huge corporation to duplicate their function. It was not realized that the majority of the *patróns*, since they fall into the middle-class bracket, have traditional ties with established export-import houses for credit and that the bank dweller in turn is tied to the *patrón* by a long-standing credit relationship. The result was that many merchants and *patróns* obliged their peons to spend their time gathering other products. Recent changes in the rubber program in Brazil have placed the responsibility for its procurement back into the hands of the big merchants who, it is now recognized, do perform an essential function with their credit, boats, warehouses, and organizational ability. Furthermore, these merchants by long experience have learned how to make their loans shrewdly, and they seldom fail to get the produce they specify in return.

As can be gathered from what has been said, this is not an ideal setup from the point of view of offering the peon an incentive to work more regularly, but it does channelize whatever work he may do to the procurement of the product the export-import houses decide should be brought out of the Amazon. It is also perhaps possible to understand why the river-bank dweller is inclined to buy only the very minimum of essentials; why he prefers to be as self-sufficient as possible and to ignore the outside world.

All these factors tend to restrict the productivity of the Amazon and, consequently, its world importance. Had it not been for its wild rubber trees, this region would have attracted little attention during the present war period, and it is doubtful whether the relatively unproductive Amazon jungles will ever again be lavished with the solicitude they have recently received. While the Valley's economic future is hardly one to excite the imagination, it will still remain the hemisphere's most fascinating field laboratory for the naturalist. The variations of fauna and flora and the magnificent profusion of plant life, which is so impressive in mass and exquisite in detail, will never fail to inspire the utmost enthusiasm of the scientific observer.

CARTOGRAPHY

By A. K. LOBECK

DURING the past two years more individual maps have been printed than in the entire previous history of the human race. The number has run literally into the billions. The vast majority of these maps have been due directly to the war. Many of them have been maps of actual battlefronts, many have been of potential battle areas, and many others have been of regions remote from the actual scene of fighting but nevertheless concerned with wartime activities. There have appeared also numerous maps of regions not involved in the war effort but which continue to be mapped as parts of a long-range mapping program of peacetime importance. All these statements apply to most of the warring nations as well as to many of those not actively participating in the conflict. In short, the many map-making agencies of the many countries of the world have indulged in the greatest orgy of map-producing and map-reproducing that the world has ever seen. Private enterprise, too, has contributed its quota, spurred on to tremendous efforts by the awakened interest in global geography in the schools and on the part of the general public. Cartography in all its phases is now a major industry.

This great avalanche of maps may be classified roughly in the following way, and it is in this order that they will be discussed:

1. *Large-scale original surveys of small areas.* These include topographic maps, harbor and coast charts, and military field maps.

2. *Small-scale compilations covering large areas.* These include maps covering entire countries and continents, aeronautical charts and navigational charts of entire oceans or large parts thereof.

3. *World maps and globes.* These are small-scale maps covering the entire world or large parts thereof, such as the hemispheres or the polar regions.

Large-scale Original Surveys. The most important agencies in the United States which prosecute original surveys are the U. S. Geological Survey, the Coast and Geodetic Survey, the Hydrographic Office of the Navy, and the War Department. Similar agencies exist in other countries. Besides these there are other governmental and non-governmental agencies which are engaged in the collecting and mapping of data of various sorts, such as those relating to soils, agriculture, geologic formations, and facts of economic interest.

The vast wartime activities of the U. S. Geological Survey have brought about an acceleration of the large-scale mapping program of continental United States, Alaska, Puerto Rico, and other outlying possessions. These so-called topographic maps, on a scale of 1:62,500, that is, about one mile to an inch, or in some cases 1:31,680, are high-class original surveys, done in the field and controlled by extremely accurate triangulation nets and level lines. The relief is shown by contours in great detail. In normal years these maps, which now cover about one-half the United States, appear from month to month as new areas are completed in various parts of the country, usually with a lag of two or three years or more between the period of surveying and the release of the printed map. During the past three years, however, the entire coastal belt extending inland for 100 to 200 miles or more has received special attention. Extensive areas in these zones have now been mapped in detail for the first time, and many other areas have been resurveyed or remapped on larger scales. A notable improvement in the quality of the maps and in the speed and in the reduced cost of mapping is due largely to the development of photogrammetry in recent years, further mention of which will be made later in this article.

On a par with the U. S. Geological Survey is the work of the U. S. Coast and Geodetic Survey and of the Hydrographic Office of the Navy. The former agency is engaged in charting the coastal waters and coastline of the United States and outlying territories; the latter, in charting foreign waters not contiguous to this country.

In peacetime the Hydrographic Office was engaged in a long-range program of surveying areas of commercial importance, mainly in the Caribbean Sea and Latin America and

U. S. Geological Survey

MAPPING PART OF THE WHITE MOUNTAINS WITH A MULTIPLEX INSTRUMENT

OPERATOR WEARS GLASSES WITH LENSES OF DIFFERENT COLORS IN ORDER TO OBTAIN A STEREOSCOPIC EFFECT FROM THE TWO IMAGES OF TWO CONSECUTIVE AERIAL PHOTOGRAPHS, WHICH ARE PROJECTED SIMULTANEOUSLY IN DIFFERENT COLORS UPON EACH OTHER. BY THIS DEVICE ACCURATE DRAWING OF CONTOURS IS POSSIBLE.

in the Atlantic and Pacific approaches to the Panama Canal. For other parts of the world reliance was placed on compilation from foreign sources, mainly Canadian and British Admiralty charts, which cover all principal coasts and ports of the world. This arrangement was made to avoid duplication of effort, under a standing agreement for the exchange of hydrographic information established by the International Hydrographic Bureau. It is obvious that every nation, so far as is possible, must rely upon the surveys of others, if only because of the vastness of the areas which must be covered. The Hydrographic Office is not limited in the areas it may survey; but customarily it restricts its operations to water beyond the limits of the United States and its territories. The war caused a shift of the Hydrographic Office to a program of surveying areas of strategic rather than commercial importance. When this country undertook the defense of Greenland, engineers were dispatched from the Hydrographic Office who worked in conjunction with the Greenland Patrol to survey areas selected for new army bases. Many soundings and other information were thus acquired and a new series of charts was constructed. The acquisition of new bases under Lend-Lease for American hemisphere defense necessitated surveys also in Newfoundland, Bermuda, the Bahamas, Jamaica, Antigua, Trinidad, British Guiana, Labrador, Baffin Land, Ecuador, and the Galápa-

gos Islands by the Hydrographic Office, prior to our entrance into the war.

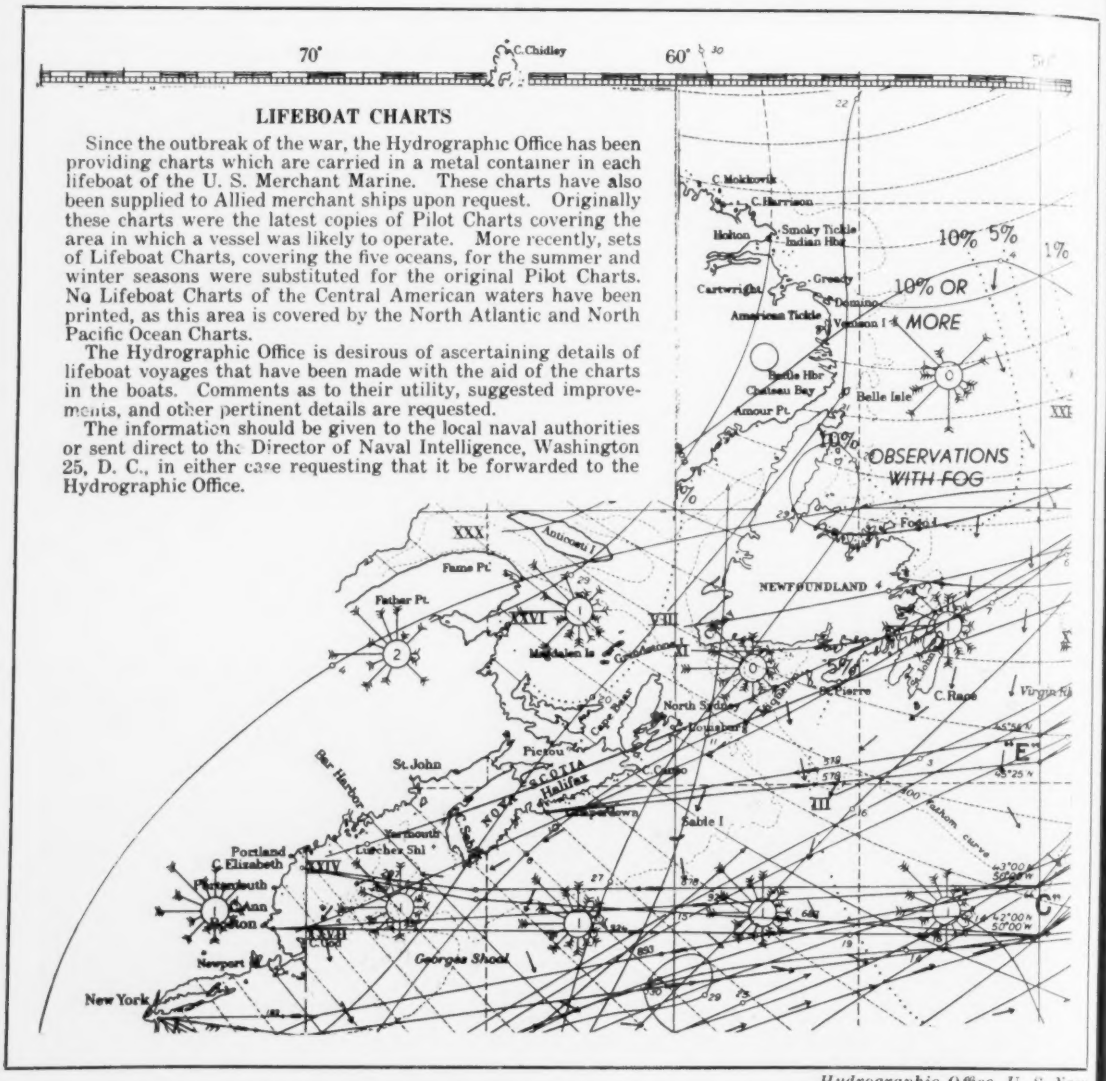
At the present time survey parties are engaged in work in the far-flung Pacific islands. These groups often find themselves forced to work in areas where the utmost precautions must be taken to avoid giving notice to the enemy of their operations. Hurried systems of triangulation are set up, perhaps under the very guns of the enemy, and surveys made which will be used to prepare charts for invasion forces. These guerrilla tactics are typical of the hit-and-run style of both water and land mapping which must exist during wartime. The usual time for production of an original chart in peacetime was about nine months for surveying and two years for construction and printing. Now, the over-all time for production aboard survey ships is about six weeks. These field charts are later returned to the central Hydrographic Office in Washington for reprinting and, if necessary, replotting and redrafting, and subsequent general issue.

Coming to the work of the War Department in the preparation of original surveys of small areas on a large scale, we may naturally assume that most of this is intimately concerned with the actual fighting fronts. Tons upon tons of maps showing in detail topographic features, with up-to-date military information, have been made available for front-line use in Africa, Italy, France, and Germany. In these areas where fairly accurate prewar maps produced by the various countries were available, the job of the army was to reprint these maps for field use, with the addition of military grids and other information, much of which was gained from aerial photographs. The large-scale topographic sheets of virtually all the countries of the world have thus been reprinted in Washington by the Army Map Service in their great new plant designed for that pur-

U. S. Navy Terrain Model Workshop

MODEL OF RABAUL, THE GREAT JAPANESE NAVAL BASE ON NEW BRITAIN

OF THE TYPE USED TO ACQUAINT BOMBER CREWS WITH THE TERRAIN AROUND THEIR TARGETS. THE COLORS OF THE SEA, THE VEGETATION, AND THE BARE SLOPES OF THE VOLCANIC CONES ARE FAITHFULLY REPRODUCED.


LIFEBOAT CHARTS
Since the outbreak of the war, the Hydrographic Office has been providing charts which are carried in a metal container in each lifeboat of the U. S. Merchant Marine. These charts have also been supplied to Allied merchant ships upon request. Originally these charts were the latest copies of Pilot Charts covering the area in which a vessel was likely to operate. More recently, sets of Lifeboat Charts, covering the five oceans, for the summer and winter seasons were substituted for the original Pilot Charts. No Lifeboat Charts of the Central American waters have been printed, as this area is covered by the North Atlantic and North Pacific Ocean Charts.
The Hydrographic Office is desirous of ascertaining details of lifeboat voyages that have been made with the aid of the charts in the boats. Comments as to their utility, suggested improvements, and other pertinent details are requested.
The information should be given to the local naval authorities or sent direct to the Director of Naval Intelligence, Washington 25, D. C., in either case requesting that it be forwarded to the Hydrographic Office.
70°
60°
C. Chidley
10% 5% 1%
10% OR MORE
OBSERVATIONS WITH FOG
NEWFOUNDLAND
Belle Isle
Fame Pt.
Father Pt.
Pictou
St. John
Halifax
Sable I.
Portland
Portsmouth
Newport
New York
Georges Shoal
C. Race
St. Pierre
400 Fathom curve

Hydrographic Office, U. S. Navy

PART OF PILOT CHART ON NORTH ATLANTIC, DESIGNED FOR LIFEBOAT USE
CURRENTS, WINDS, MAGNETIC DECLINATIONS, AND WEATHER CONDITIONS AT DIFFERENT SEASONS ARE SHOWN.

pose. These, with necessary overprints in color, are shipped to all quarters of the world, wherever they may be needed. In the battle areas, of course, emergency maps are produced from day to day and are printed just back of the lines for immediate distribution. Aerial photographs again play a very important part in making this possible.

In places like New Guinea and other Pacific areas virtually no maps were available at the outset of military operations, and it was necessary to start from scratch, with the handicap also that the enemy was almost everywhere in control of the surface. The lack of suitable maps in these areas is clearly responsible for the loss of many American lives, but it is encouraging that, with each advance now into new islands of the Pacific, maps are being made available for the armed forces through the combined efforts of the several agencies mentioned.

Small-scale Compilations Covering Large Areas. The outstanding example of a map of this kind is the International Millionth Map of the World. As originally planned

each map-making country of the world was to map its own territory on the scale of 1:1,000,000, which is about 16 miles to the inch, by compiling data from original surveys and publishing them in accordance with a standard scheme of symbols and colors. The British have been most active in the prosecution of this work and have essayed the task of doing all of Europe and much of Africa and Asia. These maps are now proving indispensable in strategic studies of these areas. This whole series has been reproduced by our Army Map Service for multifarious uses by the various governmental agencies working or planning in foreign fields. Many similar compilations on other scales might also be mentioned.

While little has been done toward the compiling of millionth maps of the United States, nevertheless a monumental job has just been completed by the American Geographical Society of New York in the publication of the millionth map of South America, Mexico, and Central America. This is a superb piece of map-making involving years of research and compilation from every conceivable source of information. Its usefulness at the present time is inestimable, and it suggests the sort of thing which still remains to be done for most of Africa and Asia, where maps are so sorely needed.

Another example of map which is essentially a compilation, rather than an original survey, is the aeronautical map of the entire United States in 87 sheets, on a scale of 1:500,000, prepared by the U. S. Coast and Geodetic Survey. As this may be had with or without the aeronautical information, it will serve a wide variety of purposes. Its scale is considerably larger than the average automobile road maps which are issued by the oil companies. Similar compilation in the form of strip maps covering the air routes of the world represents a wholly new phase of map-making which has come out of the war but which doubtless would have developed anyway during the coming years in a more leisurely manner.

During the past three years the State Department has been expanding facilities and personnel needed for the planning and construction of general and detailed maps required for the study of specific problems in the field of foreign policy. Much of the information included on these maps has been obtained by intensive investigations conducted by the research staff of the Division of Geography and Cartography, but the final design and construction of the maps has been the responsibility of the Cartographic Branch of this Division. Several hundred large colored wall maps have been prepared for use by departmental and interdepartmental committees. Before being colored by airbrush, these wall maps are reduced photographically, and copies are printed to accom-

Military Intelligence, War Department

PICTORIAL MAP OF ENEMY-HELD COAST

THIS TYPE OF ILLUSTRATION, MADE FROM AERIAL PHOTOS, WAS USED TO ACQUAINT TROOPS WITH THE TERRAIN OF INVASION COASTS WHERE GOOD LARGE-SCALE MAPS WERE NOT AVAILABLE, AS IN AFRICA.

pany documents. To reduce costs, many are colored on a ditto machine. Other special maps are drawn for color reproduction at a small ratio of reduction.

The majority of the maps produced by the Cartographic Branch portray the detailed distribution of social, economic, and historical facts. Although prepared specifically for the needs of the State Department, large numbers of the printed maps are distributed to other agencies for their use.

The public in general is more accustomed

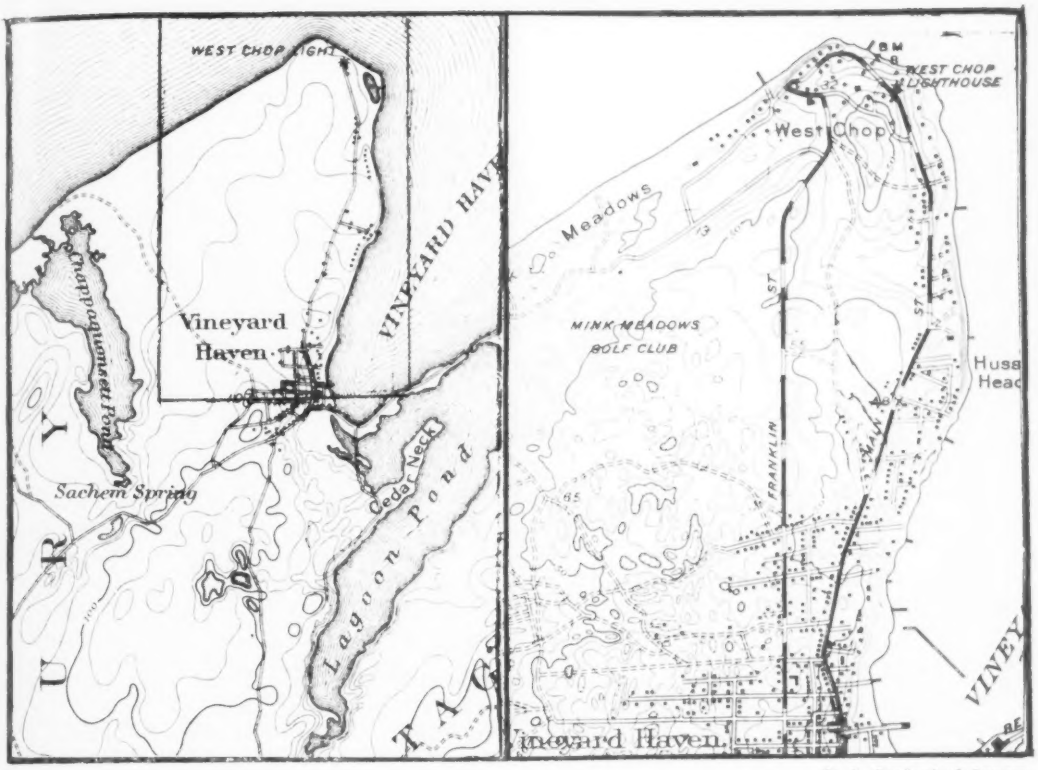
to using relatively small-scale maps of large areas, such as entire countries and continents, than of large-scale topographic sheets. Usually it is not realized that these maps are merely compilations although involving much research of original surveys and of still earlier compilations as well. This is the type of map which has been issued in recent years by the National Geographic Society in Washington. The scale of these maps is between 1:5,000,000 and 1:15,000,000. It is some satisfaction to know that although in the past the United States has lagged behind Europe in the development of this type of map, largely because of a lack of any critical understanding of maps in this country, now we are forging to the front. Hence it may be expected that in the future we shall have available maps of our country on a scale and of an excellence comparable with the best that have been made in European nations.

World Maps and Globes. In spite of the common impression that something new has come out of the war in the way of maps to illustrate global geography, it is only fair to say that such is not the case. Many people have now come to use maps practically for the first time and, having in their early days seen only about one kind of world map, they are greatly surprised when they see portions of the earth's surface represented in an unfamiliar way. The fact is that the subject of map projections, which is what is at the root of the whole matter, has been pretty well explored and understood, even for many centuries. It is true that at the present day some new notions are being exploited, but these by and large are only modifications of old established principles. This is not to decry their value. Anything which will get people to understand the geography of the globe is very desirable, but it is just as well to realize that we are not witnessing a revolution in cartographic methods.

To illustrate the sort of thing being done in the way of creating new maps or new ideas in map-making, take the modified Mercator map devised by Dr. O. M. Miller, of the American Geographical Society. He has used the Mercator map, but instead of increasing the latitudinal distances progressively toward the poles to the same extent which the Mercator map does, he arbitrarily reduced this amount and thus obtained a map which has far less exaggeration of areas in high latitudes and which, in addition, can actually extend to the poles themselves. As a world map it is highly satisfactory to the average user because (1) it covers the entire world, which the Mercator does not; (2) meridians and parallels are at right angles to each other, as they should be; (3) north is always at the top of the map; (4) east-and-west lines are always horizontal; (5) there is no undue exaggeration of areas; (6) the map has continuity. These qualities make it an admirable map for the layman, but it would be incorrect to say that it is better than a Mercator map because as a matter of fact it fails utterly to do the very thing for which the Mercator map was in the first place designed to do—to preserve directions so that the map may be used for navigational purposes. This may be taken as one of the many so-called improvements or innovations in map-making. Such things appeal to the public, because it is interested in getting something that is easy to understand and that adds to its convenience even though by so doing it is losing something else of much greater fundamental value.

One of the newest devices which helps to bring out the global aspects of the world is a globe which rests in a hollowed-out base like a golf ball on a tee. It may readily be turned in any direction for convenience of observation. Fitting closely over the globe is a transparent celluloid hemisphere which may be moved to any desired position so that its center can be placed over any point on the earth's surface. A series of concentric circles engraved on the hemisphere makes it possible readily to see what places lie at any given distance from the center. The rim of the celluloid hemisphere, being a great circle, may be turned to indicate the path on the earth's surface of the great circle which passes through any two given points. It is quite impossible to do this with any map unless the map has been designed for just this purpose, and such a map is not satisfactory in other respects.

The concept of great circles and the fact



U. S. Geological Survey

OLD AND NEW MAPS OF PART OF MARTHA'S VINEYARD

Left: MAP SURVEYED IN 1887 AND PUBLISHED ON SCALE OF 1: 62,500, CONTOUR INTERVAL 20 FEET. *Right:* 1944 EDITION, SCALE 1: 31,680, CONTOUR INTERVAL 10 FEET. NOTE VAST AMOUNT OF DETAIL IN TERMINAL MORAINE THAT IS DEPICTED ON THE LATER MAP, DUE NOT ONLY TO SMALLER CONTOUR INTERVAL BUT ALSO TO INFINITELY GREATER CARE IN STUDYING THE REGION, BOTH ON THE GROUND AND FROM AERIAL PHOTOGRAPHS.

that they represent the shortest distance between two points on the earth's surface have become common knowledge in recent years, owing largely to the advent of the airplane in long-distance flying. People have, as a result, become surprised to discover that the polar regions lie along the direct route between certain important places in the Eastern and Western Hemispheres. Maps centered upon the North Pole have therefore become so popular that some people have been misled into thinking that the so-called air age has introduced some radical innovations in the field of map-making. With the appearance of articles in magazines criticizing the use of some of our best-known world projections, like the Mercator map, because of the great distortion of features in the polar regions, and advocating instead other kinds of projections which do not have this fault, though they may have other and worse faults, and with the appearance of atlases showing parts of the earth viewed from unusual directions, and combined with all this still more articles which remind us that there can be no final solution to the problem of representing the surface of a globe on a flat plane, the layman is left in a bewildered state. He feels sure that something has been happening in the cartographic world, but he can not quite make out what the contribution has been. Perhaps it will ease his mind to know that all these apparent novelties are only old ideas in a new dress. If the layman learns anything from the study of maps in this war it should be that there is no reason to say that any particular map or map projection is better than another one. Every map is a compromise. Some maps are good in some respects, other are good in other respects.

The Mercator map, for example, is the only world map which preserves directions correctly, and it is therefore the map best suited to navigation. Among the attributes which are striven for in the making of maps are correct scale throughout the map, correct scale in certain directions only, correct directions, correct shapes, correct areas, the representation of great circles by straight lines, and continuity. On large-scale topographic maps covering very small parts of the earth's surface, inaccuracies in the above-mentioned particulars resulting from the kind of projection used are virtually negligible. But on world maps or maps of large areas rarely can more than one or two of these desirable attributes be found on the same map. That is one reason why we have so many different kinds of maps.

A REVIEW of the whole long history of map-making shows relatively few fundamental discoveries. Two of them deserve comment in the light of present developments. They are: the accurate determination of longitude and the accurate representation of topographic features. The former has to do with horizontal location, the latter with vertical position.

The determination of longitude depends upon the exact difference in time between the place in question and the prime meridian. When it is realized that an error of one second of time means an error of about one-third of a mile in the true position on the surface of the earth, it is easy to see that before the advent of highly accurate chronometers positions in longitude might be scores if not hundreds of miles out of the way. In fact, when the British Navy began to develop clocks for navigation they were content to get timepieces which did not vary more than two minutes between Britain and the West Indies, and this meant determination of longitude to only within 50 miles. An accuracy to within 100 miles was considered good. Now, however, we have an instantaneous report of Greenwich time by radio to any part of the world. This means that within recent years, with the advent of short-wave reception to the remotest parts of the world, it is possible to map out-of-the-way places like the Pacific islands, rivers in the Amazon Basin, and localities in the Arctic with a greater precision and with greater ease and less expense than were possible even with the best of clocks.

Concerning the representation of relief, it may be observed that the oldest maps of which we have records, even old Chinese maps, showed hills and mountains by picturesque symbols which looked more like little tents or wigwams than anything else. Then came the representation of relief by means of crude hachures, a method which has been much refined and artistically developed by several European countries. But the most revolutionary device was the invention of contours in the eighteenth century. Contour lines which connect places of equal elevation provide by all odds the best method of representing the precise character of all kinds of terrain, even that which is covered by water. Large-scale topographic maps employing contours to show the relief are virtually indispensable in military work as well as in engineering projects of all kinds. All such maps until recent years have been prepared on the ground by the use of the plane-table and similar surveying devices which necessitated covering the entire area on foot. But the airplane has now become available, and with it there has arisen the new science of map-making from aerial photographs, called photogrammetry. This does not do away entirely with all ground work, but it does enable vast areas to be mapped far more easily and rapidly and in some respects more accurately than is possible by working on the ground alone. Highly intricate mechanical devices based upon the principles of the stereoscope make use of overlapping pairs of photographs, and by this means even very subdued topography may be mapped. Contour intervals of only two feet have been found practicable.

Comparison between the earlier contour maps produced in this country and the more recent ones of the present day reveals a great improvement in the delineation of topographic features. Much of this is due to the development of the science of geomorphology, or the understanding of the meaning of landscapes and their geological explana-

tion. It is necessary to realize that a contour map is not a purely mechanical device to show differences in elevation. It is a kind of portrait which expresses at the same time the individual qualities of the region. A good topographic draftsman must be not only a topographic engineer but also something of a geologist and a geomorphologist, to say nothing of being an artist as well. He must portray the topography with such skill that the map can be interpreted in terms of its rock structure, its soil, and to some extent its geological history. A comparison of the new topographic sheets of the island of Martha's Vineyard issued by the U. S. Geological Survey in 1944 with those issued in earlier years brings out this point in a striking manner.

Of comparable value to the airplane in mapping land surfaces are the new sonic devices for mapping the sea floor. Extremely accurate results are now obtainable by this method, and it is becoming customary to make charts with depths indicated by contours, instead of by spot soundings with which most of us have in the past been familiar.

The essential advanage of sonic sounding is that it can be done from a ship underway, and that for great depths (one mile or more) it is considerably more accurate than soundings made with a line. In deep soundings with a line, currents and wind drift in the ship make the line deviate from the vertical. Also it is hard to tell when you hit bottom.

The importance of relief in military activities is now so well understood that widespread use is made of all kinds of other devices such as diagrams and models. A type of drawing known as a physiographic diagram or map has in recent years been developed to portray pictorially the nature of the relief over large areas, designed primarily for strategic studies. A picture of this kind provides a means whereby a quick glance reveals the disposition of the mountains and plains, their intimate topographic character, whether they are much or little dissected, whether the country is rolling or rough, the nature of the passes, gaps, corridors, and other features of military significance. They have proved especially helpful to those who are not familiar with the use of contour maps. Because of the ease and the rapidity with which such pictorial drawings can be read, they were used by landing parties at the time of the African invasion and on other similar occasions.

A full account of recent cartographic developments should include also the new techniques in model-making which have been developed in special army and civilian schools. A good model assumes a good map or good aerial photographs as the source of information. Models range from those of small scale covering whole continents to those of very large scale representing beach heads or bombing targets upon which even the individual buildings are accurately represented to scale and even to color. The significant point of the matter is that a keen understanding of the relief and its meaning is now a requisite in all military planning, be it for extended or for restricted operations, and it has been found that in some respects models provide the ideal medium for the accomplishment of that purpose.

In the October 1944 number of The Scientific Monthly, Rear Admiral G. S. Bryan said some good words in favor of the much maligned Mercator projection. He recommended this as the most all-round useful world map for the average layman. With the Mercator map, in order to cover the polar regions, he suggests the equidistant polar projection. These two maps are the ones that have been used for years in our school geographies. I heartily support Admiral Bryan. In fact, I might go even a step further toward simplicity and substitute for the Mercator map an equidistant cylindrical projection. This projection and the corresponding equidistant polar projection can be laid out by any student with a ruler and compass. These are the simplest and most easily understood of all projections.

In the same month Admiral Bryan published a most illuminating, interesting, and well-illustrated article on the wartime work of the Hydrographic Office of the U. S. Navy, in *The Military Engineer*. To this article I am indebted for some of the information presented here.

SOME INSECT INFANTS

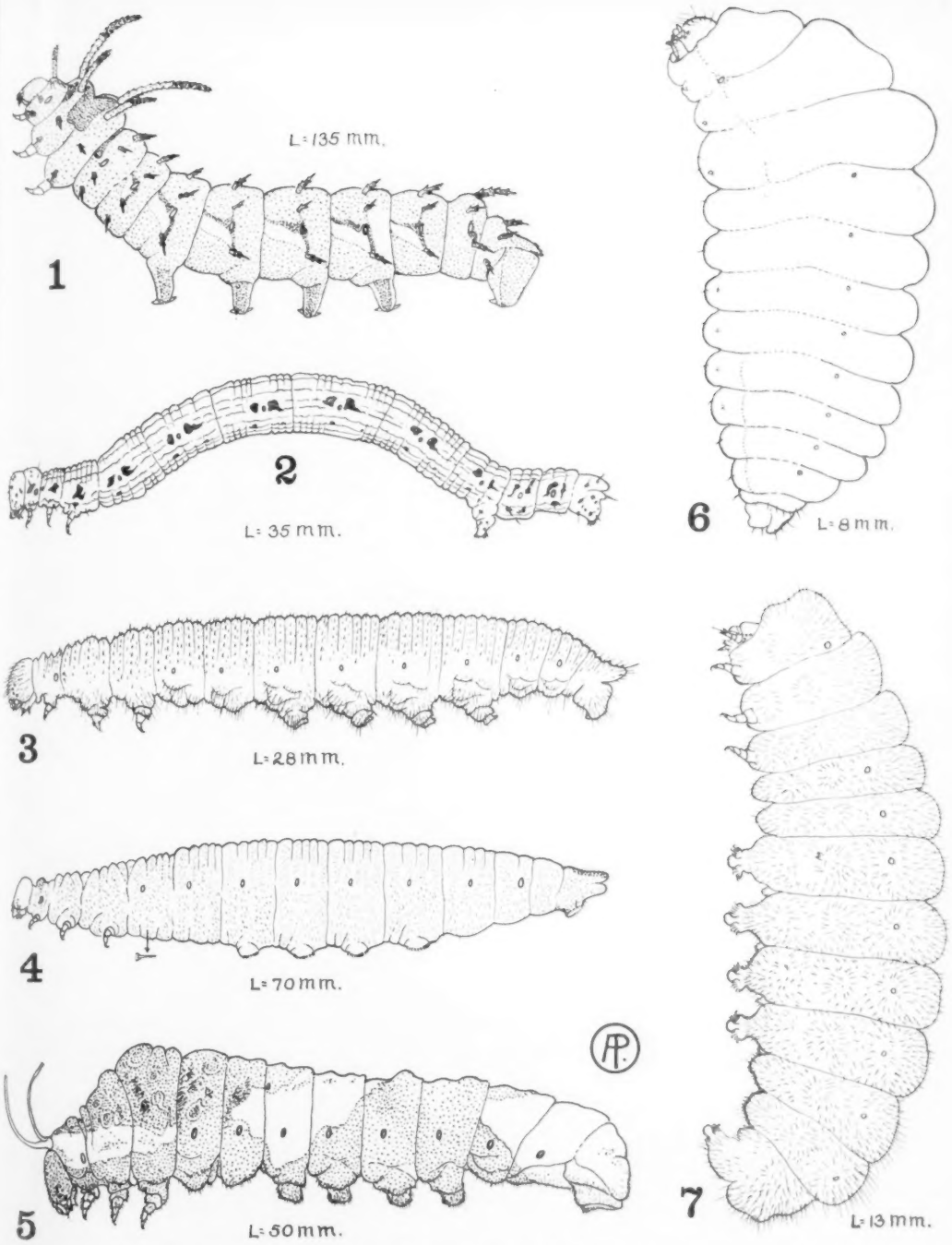
By ALVAH PETERSON

MAN has frequent and varied experiences with insects. These contacts, by sense of sight, hearing, touch, or smell, are most frequent during the warm season of the year. If the six-legged creatures, commonly called bugs, possess well-developed wings, they are adults. If they are wingless or possess wing pads, they are apt to be immature stages, some of which may be wormlike.

All insects come from eggs; the vast majority, however, come from eggs deposited by the female, while a few develop within the body of the female and are born alive. Adult insects never produce winged adults directly. In other words, big flies never give birth to small flies, nor do small adult flies increase in size and become larger flies. When an insect reaches the adult stage it undergoes no marked change in size or form. All newly hatched or newly born insect infants may be placed into one of two categories. They are nymphs or larvae. If they are nymphs (some species are called naiads) they resemble the adult in form, and their feeding habits and habitat are apt to be the same as those of the parents. Some of the common insects possessing nymphs, which gradually develop into adults, are grasshoppers, cockroaches, crickets, termites, aphids, leafhoppers, thrips, plant bugs, earwigs, and sucking lice. If they are larvae they are apt to have little or no resemblance to the adult. Their feeding habits may be very different also, and they may live in an environment far removed from that of the parents. Some of the common names applied to larvae are worms, caterpillars, grubs, borers, maggots, and wrigglers. The following are some of the common insects that possess larvae: all moths, butterflies, beetles, weevils, curculios, flies, mosquitoes, gnats, sawflies, hornets, ants, and fleas.

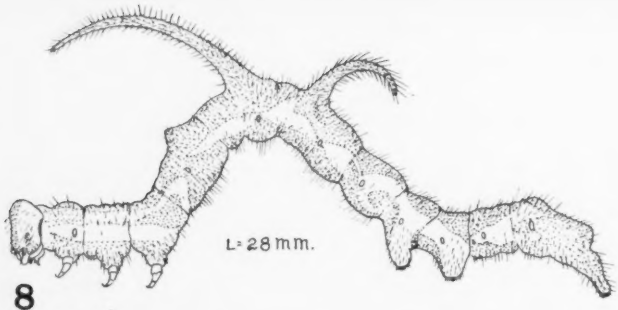
This article is restricted largely to a general discussion and illustration of insect larvae. Following an introduction and the presentation of information on collecting, a number of common species and a few unusual forms found in North America are discussed. The general groupings (orders) include the larvae of moths and butterflies, beetles, two-winged flies, fleas, four-membranous-winged forms, and nerve-winged insects. The common names used for the various groups and species are, for the most part, those found in the list of approved common names assembled by the American Association of Economic Entomologists, or in Comstock's *Introduction to Entomology*. The number of species given for each order are close approximations of the number of species existing in the United States and Canada.

All insect larvae during their postembryonic development from the egg to a full-grown worm pass through several molts, commonly three to seven. The insect between each molt is called an instar. Each larval instar may be very distinctive and differ greatly in form, detail of structure, and size from the preceding or following instar. This condition in a given species adds to the complexity of larval recognition. When the last larval instar has completed its feeding and is full grown, it may spin a cocoon or prepare a cell and then assume a prepupal condition in which it becomes quiescent, consumes no food, and contracts its length somewhat. The prepupa usually sheds its outside skin and then a true pupa appears. In many species the pupa resembles a mummified adult insect, possessing all the adult appendages within cases held close to the body. In most instances the pupa is also quiescent and consumes no food. Pupae of some aquatic flies, namely mosquitoes and midges, are exceptions in that they are considerably active. Internally the tissues of the pupa undergo a complete reorganization and produce an adult male or female. Eventually the adult insect within exerts pressure along the back, splits the pupal shell lengthwise, and emerges as a helpless soft-bodied creature. It immediately inflates its wings. As soon as the wings, legs, and body covering (exoskeleton) harden, the insect is ready to fly or crawl away and carry on the chief function of its adult life—reproduction.

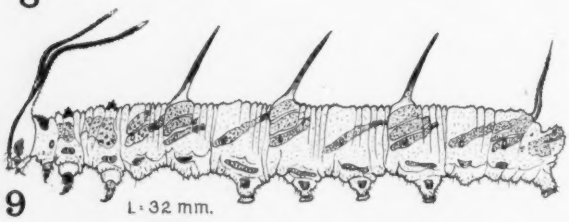


CATERPILLARS OF MOTHS AND BUTTERFLIES (LEPIDOPTERA)

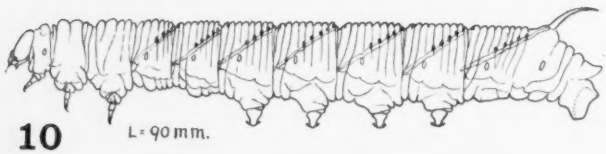
1, HICKORY HORNED DEVIL, REGAL-MOTH CATERPILLAR (*Citheronia regalis* (F.)); 2, CHAIN-SPOTTED GEOMETER OR MEASURING WORM (*Cingilia catenaria* (DRURY)); 3, IMPORTED CABBAGE WORM (*Pieris rapae* (L.)); 4, AN EDIBLE DELICACY IN MEXICO, *Aegiale hesperiaris* WLK.; 5, ORANGE DOG CATERPILLAR (*Papilio cresphontes* CRAM); 6, BOGUS YUCCA MOTH (*Prodoxus quinquepunctellus* CHAM.); 7, COTTON-SQUARE BORER ON BEAN PLANTS (*Strymon melinus* (HBN.)). FIGURES 3, 5, AND 7 ARE BUTTERFLIES; OTHERS ARE MOTHS.



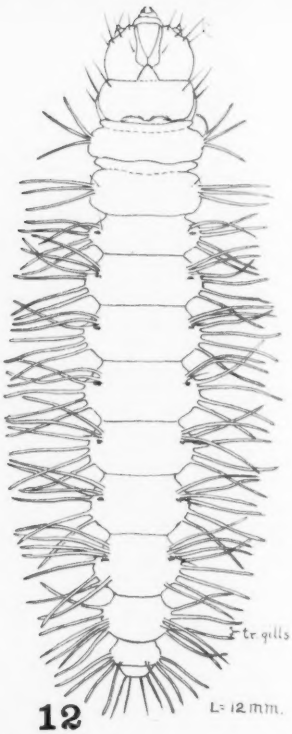
8



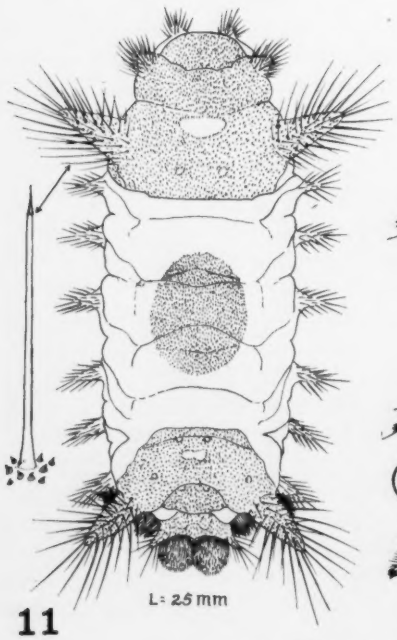
9



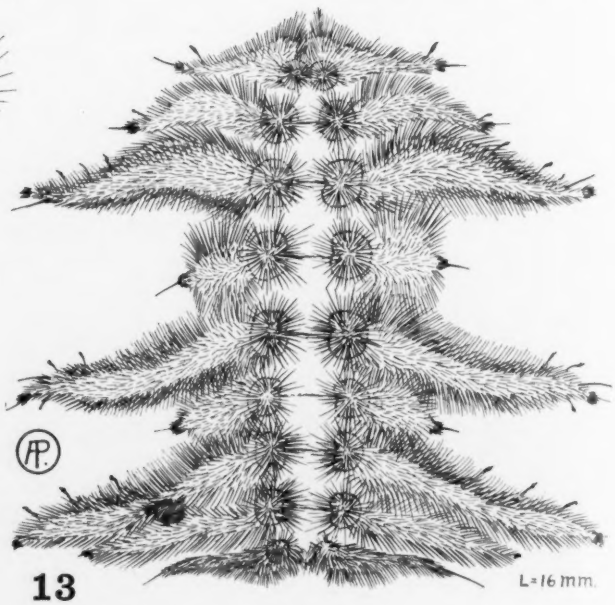
10



12



11



13

CATERPILLARS OF MOTHS (LEPIDOPTERA)

8, AN ORNATE FALSE MEASURING WORM (*Sudariophora acutalis* WLK.); 9, AN ORNATE NYMPHALID CATERPILLAR ON FIGS IN FLORIDA (*Athena petreus* CRAM); 10, TOBACCO HORNWORM (*Protoparce sexta* (JOHAN.)); 11, POISONOUS SADDLEBACK CATERPILLAR (*Sibine stimulea* (CLEM.)); 12, AQUATIC WEB-SPINNING PYRALID (*Cataclysta fulicalis* CLEM.); 13, HAG-MOTH CATERPILLAR ON APPLE (*Phobetron pithecium* (A.&S.)).

Such is the life cycle of all insects possessing larvae. Briefly stated, all species pass through an egg, larva, pupa, and adult stage. These insects are said to undergo complete metamorphosis in contrast to nymphs which undergo incomplete, gradual, or no metamorphosis.

Some of the most remarkable transformations to be found in nature occur among insects that undergo complete metamorphosis. Unfortunately most of these marvels are never seen by the average person, because most insects are too small to be observed in detail by the naked eye. If insect larvae were ten to many times their present size, the average person would be more apt to note some of the wonders of the insect world. Fortunately today excellent hand lenses and binocular microscopes are available. A good pocket hand lens, magnifying approximately ten diameters, would bring to any child or adult an awareness of these unusual insect phenomena, which are to be found everywhere about us.

Many species of insects are, during their larval development, most destructive or only destructive to plants, food, clothing, or farm animals. This is true of many or all insect pests among beetles, moths, butterflies, flies, and sawflies. Many farmers and food producers know only the destructive larval stage of certain pests. They may never have seen the eggs, pupae, or adults. For example, intelligent fruit growers readily recognize the larvae of the codling moth or the apple maggot in their apples, also the worm stage of the oriental fruit moth or the plum curculio in their peaches, but may not know the parents of these pests. Wheat farmers know the maggot, or puparium, of the Hessian fly in their wheat, and yet few farmers or entomologists have ever seen living specimens of the tiny fly which deposits its eggs on the wheat. The same can be said for cattlemen who recognize the cattle grubs (Fig. 42) under the hide of cattle or the screwworm maggots (Fig. 39) in open sores on the body of their stock but do not know the adult flies responsible for the infections.

A recent census of insects shows that there are 79,840 recognized species in North America north of Mexico. An analysis of the figures given for the various orders reveals that 68,900 species belong to orders that possess larvae. Briefly stated, at least 85 per cent of all insects in North America pass through a larval stage in their development. Further analysis of insect pests that attack apple, corn, cotton, shade trees, and other plants of value to man shows that 50 to 60 per cent of all plant pests in the Temperate Zone are destructive as larvae. This situation, recognized by most entomologists, makes it imperative that a professional economic entomologist be able to recognize many pests in the larval stage. Control measures for a particular pest on plants in many cases are very specific and applicable only against larvae. If an entomologist had to depend upon the determination of a given destructive larva from an expert some distance away or if he attempted to rear the larva to maturity in order to recognize the species before applying the control measures, it might be too late to save the crop.

One of the most striking examples today of the value of larval recognition is associated with mosquito control. In our armed forces competent entomologists are playing an important role in the fight against insect-borne diseases, particularly malaria and yellow fever. They can do this thoroughly because they know the species of mosquitoes. It is well established that certain species of anopheline mosquitoes transmit specific malarial organisms to man. To control malaria it is necessary to control the breeding areas of the dangerous species. To determine the breeding areas the species of larvae living in the water must be recognized. When breeding areas of specific anopheline larvae are spotted, then proper control measures for killing the larvae or the prevention of further breeding may be put into operation.

Another example of the importance of recognizing insect species in the larval stages is associated with the quarantine inspection of all plants and plant and animal products entering this country. Many foreign plants or plant and animal products entering this country possess larvae of undesirable species. These larvae must be recognized by competent entomologists in order that important exotic pests may be prevented from gaining

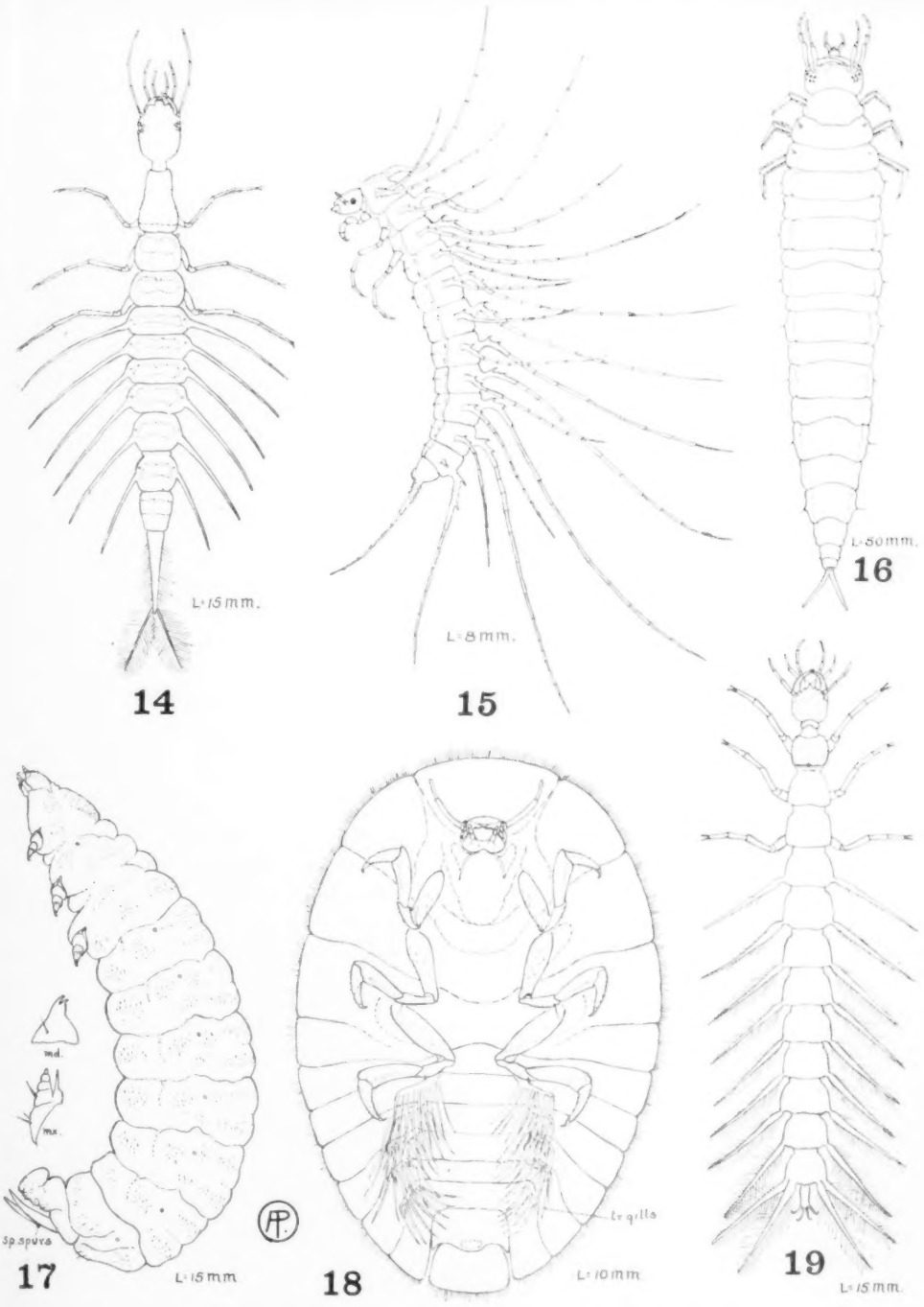
a foothold in the United States. Too many foreign species have already established themselves here, and they are costing us millions of dollars every year. Most of the undesirable established species entered this continent before we had rigid and competent quarantine inspection. In many cases these exotic species must have entered as eggs, larvae, or pupae.

Entomologists in general recognize more species of insects in their adult stage than in their immature stages. No attempt will be made to discuss the reasons for this; however, the following statements will explain partially this situation. All scientific names of insects are based on the characters of the adult male and female. For many years, and to a limited extent today, entomologists have assembled large collections of adult insects. Very few entomologists in the past or today, however, collect insect infants. The ease with which one may collect, kill, and pin adults accounts in considerable measure for the large and beautiful collections of moths, beetles, flies, true bugs, etc., made by amateurs and professionals during the past 50 to 75 years. The situation is different for most immature stages, especially larvae. Larvae in many cases are difficult to locate and collect. They cannot be killed satisfactorily in a cyanide jar; furthermore, they shrivel and turn black if pinned for preservation.

Larvae are usually killed in hot water or in one of several chemical solutions at room temperature in order to retain the normal form. One of the most satisfactory killing solutions is a mixture of kerosene (1 part), ethyl alcohol (10 parts) and acetic acid (2 parts). After the larva is dead and completely distended, it is usually preserved in 80 to 95 per cent ethyl alcohol. Since alcohol evaporates slowly in a corked bottle, special precautions have to be taken to prevent evaporation and the deterioration of a wet collection. The killing methods mentioned above usually destroy the bright colors of many larvae, especially the greens, yellows, or oranges, of caterpillars. To preserve color a larva must be inflated and dried. To do this the caterpillar or larva is killed in a cyanide bottle and immediately the alimentary tract is severed at the anal end. All the liquid and internal contents are removed by pressure. After the specimen is completely empty, deflated, and flattened, a small glass tube connected with an air line is inserted into the anal end and tied in position. A very low pressure of air is then employed to inflate the larva again to normal size. The inflated moist larva is held in a warm drying chamber until the outer shell is completely dried and hardened. Then the glass tube is carefully removed, and a mounting plug located on a pin is inserted and glued to the anal end if so desired. When this process is completed the result is an inflated specimen usually of normal size with all its hairs, spines, and original color intact. These inflated specimens, if properly prepared and mounted, produce a beautiful display of life-like larvae. The outstanding objection to an inflated collection is the fact that the specimens are exceedingly fragile and have to be handled with extreme care.

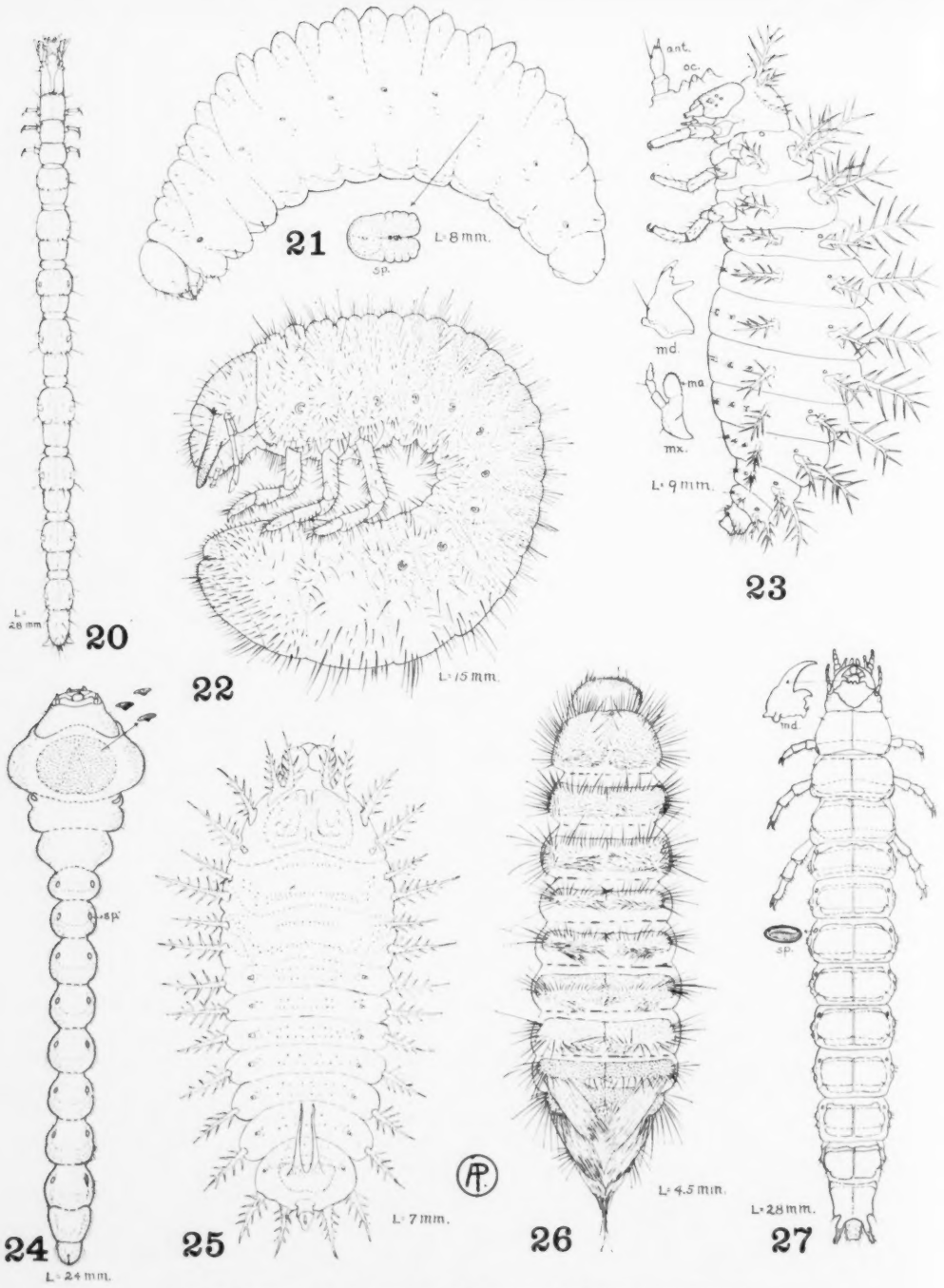
Larvae of most moths, butterflies, and skippers (Lepidoptera) are called caterpillars. Figures 1–13 illustrate some of the common and unusual species. Caterpillars resemble one another more closely than do the larvae of beetles or flies. Full-grown caterpillars may be 5 inches long (regal-moth larvae, Fig. 1), while others may be less than one-eighth inch when full grown (many leaf-mining species). Many common caterpillars are 1 to 2 inches long. Practically all species are terrestrial in habits; a few pyralids (Fig. 12), however, live in water on stones or submerged vegetation. The food of most caterpillars is plant tissue. The majority of species feed on foliage, stems, roots, buds, blossom, or fruit, while some species bore within stems, buds, fruit, or roots of plants. A number of species live on plant products, a few on animal products, while a small number are predacious on other insects.

In the United States and Canada there are more than 10,000 described species of moths, butterflies, and skippers. The larval stages and habits of many of these are unknown or have never been described. Most caterpillars are wormlike, elongated, segmented, and cylindrical in shape (Fig. 3). Each pos-



AQUATIC LARVAE OF BEETLES (COLEOPTERA).

14, PREDACIOUS DIVING-BEETLE LARVA (*Coptotomus* SP.); 15, HALIPLID-BEETLE LARVA (*Peltodytes* SP.); 16, WATER-SCAVENGER-BEETLE LARVA (*Hydrous triangularis* (SAY)); 17, A DEEP-WATER *Donacia* LARVA; 18, WATER-PENNY (*Psephenus lecontei* (LEC.)); 19, WHIRLIGIG-BEETLE LARVA (*Dineutes* SP.).



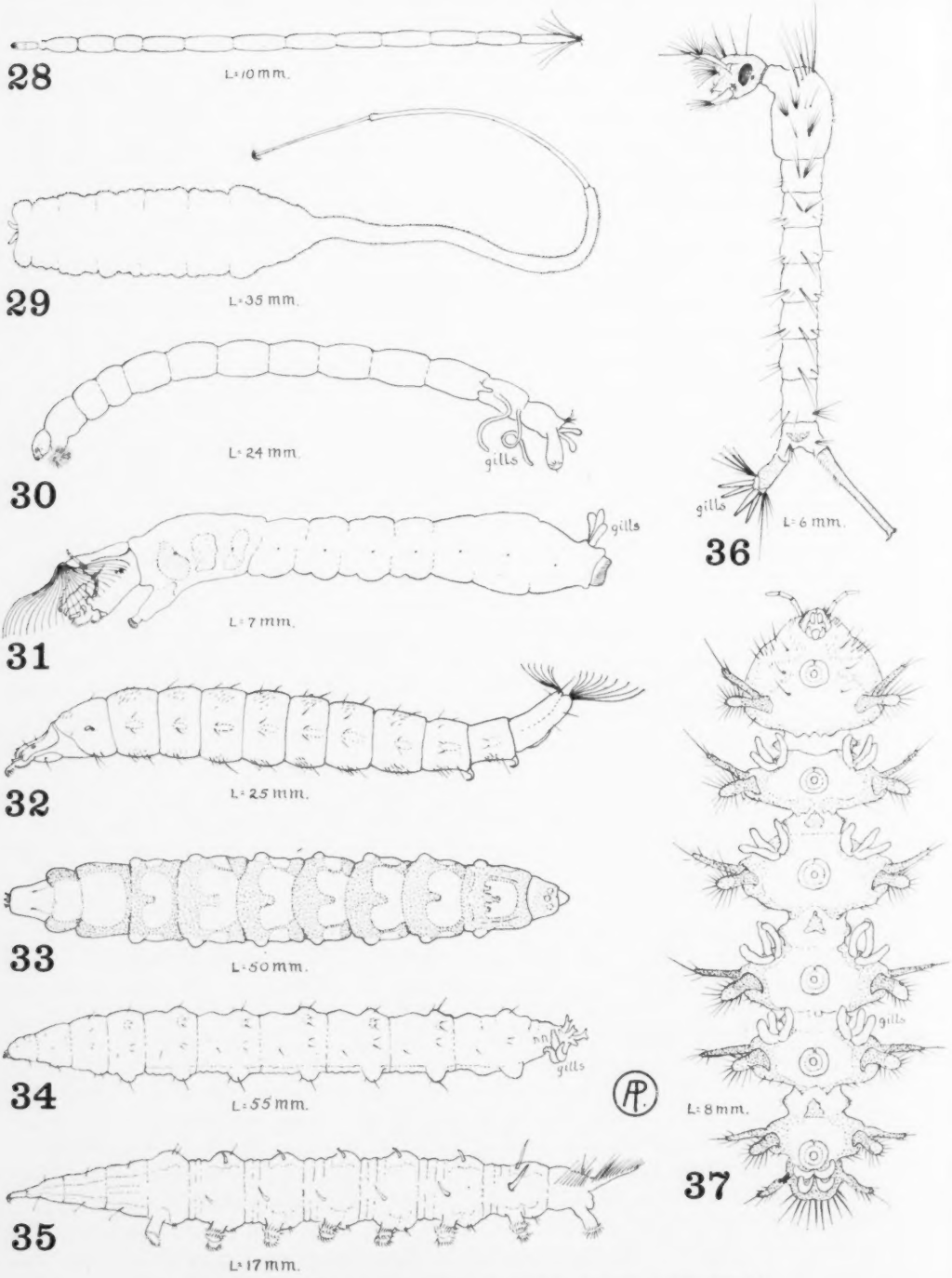
TERRESTRIAL LARVAE OF BEETLES (COLEOPTERA)

20, SAND WIREWORM (*Horistonotus uhlerii* HORN); 21, COTTON-BOLL-WEEVIL LARVA (*Anthonomus grandis* BOH.); 22, JAPANESE-BEETLE GRUB (*Popillia japonica* NEWM.); 23, MEXICAN BEAN-BEETLE LARVA (*Epilachna varivestis* MULS.); 24, FLAT-HEADED APPLE-TREE BORER (*Chrysobothris femorata* (OLIV.); 25, TORTOISE-BEETLE LARVA ON NIGHTSHADE PLANTS (*Cassida rubiginosa* MÜLL.); 26, CARPET-BEETLE LARVA (*Anthrenus verbasci* (L.)); 27, GYPSY-MOTH CARABID PREDATOR (*Calosoma sycophanta* L.).

sesses a distinct, firmly constructed head bearing chewing mouthparts, a spinneret, and a crescent-shaped group of four to six simple eyes on each side. Immediately back of the head the segmented thorax usually bears three pairs of jointed legs. The remainder of the body comprises the abdomen, consisting of ten segments usually bearing five pairs of fleshy prolegs on segments 3, 4, 5, 6, and 10. Minute grasping hooks are usually present on the prolegs. Breathing pores (spiracles) usually occur on the first segment back of the head and also on each of the first eight abdominal segments. The head and body may be naked (tomato or tobacco hornworm, Fig. 10), that is, without numerous prominent hairs, or the head and body may be profusely covered with numerous scattered or bunched short or long hairs or spines (woolly-bear, mourning-cloak, or hag-moth caterpillars). Some caterpillars possess hairs or spines that are distinctly poisonous to man if they come in contact with the skin or are inhaled (saddleback caterpillar, Fig. 11, io moth, or browntail moth).

Most caterpillars spin a silken thread. The silk comes from long, smooth, tortuous, tubelike glands located on the inner surface of the body wall near the spiracles and extend the entire length of the body. These glands are seen readily in dissected specimens especially if the larva has been killed in the mixture described above. The glands force their semifluid secretions forward through a single tiny nozzlelike spinneret located on the lower lip of the mouth parts. Upon exposure to air the soft secretion hardens and produces a strong silk fiber. The silk thread is used by caterpillars for various purposes. Most terrestrial caterpillars feeding on plants or plant products spin a continuous silk line wherever they crawl. By attaching this thread to the surface over which they crawl they use it as a safety line in case the larva loses its foothold. This may be observed readily in the case of the cankerworms. If one jars a branch on which cankerworms are feeding, many of the larvae will fall from the leaves and each will suspend itself in midair by a silken thread. The silken thread may serve also as a guide line for a larva crawling over plants. When walnut caterpillars crawl down the side of a tree to undergo a molting period the individuals of the next instar will return to the upper part of the tree along the line of silken threads deposited by the larvae going down the tree. Silk is used by larvae also in the construction of portable bags or cases about the body, especially among bagworms, casebearers, etc. The most common use of silk by caterpillars is in the construction of a cocoon or silken chamber about the full-grown larva in preparation for the pupal stage. For many centuries man has derived natural silk from the cocoon of the common silkworm. The full-grown silkworm after it completes its last meal on mulberry foliage spins a light cream-colored cocoon about its body. This cocoon consists of a continuous silken fiber when completed. The end of this fiber is located and then it is carefully unwound. It takes several fibers to construct a single silk thread.

A few examples of the many interesting and unusual habits and forms which occur among caterpillars might be mentioned. Some species (larvae of swallowtails, Fig. 5) possess protrusile, fingerlike glands back of the head which emerge and secrete repellent odors when the larva is disturbed. Other larvae (cutworms) if disturbed will curl up and remain in this position for a prolonged period of time. Some species if touched undergo violent contortions (many leaf rollers), while others may become very rigid (some measuring worms or notodontids). Leaf-feeding larvae, especially the late instars, consume great quantities of food. The large quantity of excrement in the form of pellets under a tree is mute evidence of the amount of foliage consumed even when the number of individuals is not excessive. Some larvae (oriental fruit moth, etc.) possess a forklike structure above the anus which is used to flip feces away from the body as soon as they appear. Other caterpillars are legless, a good example being the larva of the bogus yucca moth (Fig. 6). Some species possess unusually ornate structures; see Figures 8, 9, 11, and 13. In Mexico a large white megathymid larva found in the leaves of the maguey, or century plant, is used as human food. This delicacy is usually fried in a vegetable or animal fat, and the



AQUATIC LARVAE OF TWO-WINGED FLIES (DIPTERA)

28, A THREADLIKE MIDGE LARVA (*Probezzia* SP.); 29, RAT-TAILED MAGGOT (*Eristalis* SP.); 30, COMMON MIDGE LARVA (*Chironomus* SP.); 31, BLACK-FLY LARVA (*Simulium vittatum* ZETT.); 32, SOLDIER-FLY LARVA (*Stratiomyiidae*); 33, BLACK HORSEFLY OR TABANID LARVA (*Tabanus atratus* FAB.); 34, GIANT CRANE-FLY LARVA (*Tipula abdominalis* SAY); 35, SNIPE-FLY LARVA (*Atherix variegata* WLK.); 36, COMMON MOSQUITO WRIGGLER (*Aedes* SP.); 37, NET-WINGED MIDGE LARVA (*Agathon canadensis* GARRETT).

flavor of the cooked caterpillar is somewhat similar to that of potato chips. The prepared product may be purchased in tin cans under the name "Gusanos de Maguey Fritos."

There is no common name for beetle (Coleoptera) larvae comparable to caterpillars, the name applied to the larvae of most moths and butterflies. In some cases the larvae of beetles are called grubs, worms, or borers; more specifically they may be referred to as white grubs, wireworms, rootworms, glowworms, round-headed borers, flat-headed borers, etc. A greater diversification in form occurs among beetle larvae than among caterpillars. Figures 14–27 illustrate some of the common and unusual species. So-called grubs, typical of several families especially the scarabs, are described as C- or U-shaped (Fig. 22) and resemble a round doughnut with a bite taken from one portion. Crescent-shaped larvae (Fig. 21) with both ends somewhat pointed are common for many curculionids and weevils. Other beetle larvae are straight, elongated, and cylindrical. These may be very slender (sand wireworms, Fig. 20) or plump (eyed elater larvae). Some aquatic species may be flattened and disklike (water-penny, Fig. 18), while others are elongated and spindle-shaped (water-scavenger, Fig. 16). Practically all coleopterous larvae are naked except for numerous microscopic hairs on some species. Exceptions may be found among species of dermestids (Fig. 26), Mexican bean beetle (Fig. 23), tortoise beetle (Fig. 25), and aquatic species (Fig. 15).

Full-grown beetle larvae rarely exceed 3 inches in length, while many are very small, less than one-eighth inch long. In general, the species are smaller than most caterpillars. In the United States and Canada more than 25,000 species of beetles have been found. The immature stages of many are unknown or have not been described. All beetle larvae possess a distinct, firmly constructed head with chewing mouthparts. Simple eyes, if present, are never crescentlike in their arrangement, nor are spinnerets ever present on the head. The thorax immediately back of the head usually possesses three pairs of jointed legs. These may be absent among larvae of the curculios, flat-headed borers, etc. The abdomen consists of eight to ten segments which possess no prolegs except on the last segment in a few species. Breathing pores (spiracles) are usually present among terrestrial species on the second thoracic segment and on the first eight abdominal segments.

Beetle larvae are largely terrestrial; however, there are a few families in which most of the larvae live in water. The common names of some are diving beetles, water-scavengers, whirligigs, and water-penny. Many of the terrestrial larvae live in soil and feed on grass roots and rootstocks. Some good examples are grubs of the Japanese beetle (Fig. 22), green June bugs, and May beetles. Wireworms (Fig. 20) are also commonly found in the soil and may be very destructive to potatoes, newly planted corn, and beans. Larvae of beetles feed on a more diversified list of products than caterpillars. In addition to the many species that live on or within living plants or plant products (wood, prepared food, etc.), the species of a large number of terrestrial and aquatic forms are strictly predacious, feeding on other insects or aquatic life, such as snails, small fishes, and crustaceans. Some of our most beneficial larvae, namely, those of the ladybird beetles and many ground beetles (carabids, Fig. 27), consume great quantities of destructive insects. In many local situations they completely control insect outbreaks. Other species of beetle larvae are strictly scavengers, living in or on dead or decaying animal and plant tissue. Some of these are larvae of carrion beetles, rove beetles, and dermestids. Some dermestids will consume all the muscle and other tissues attached to vertebrate bones but do not eat the bone itself; consequently, some museums have used dermestids in preparing skeletons for display. Some beetle larvae obtain all their sustenance from living or dead fungi.

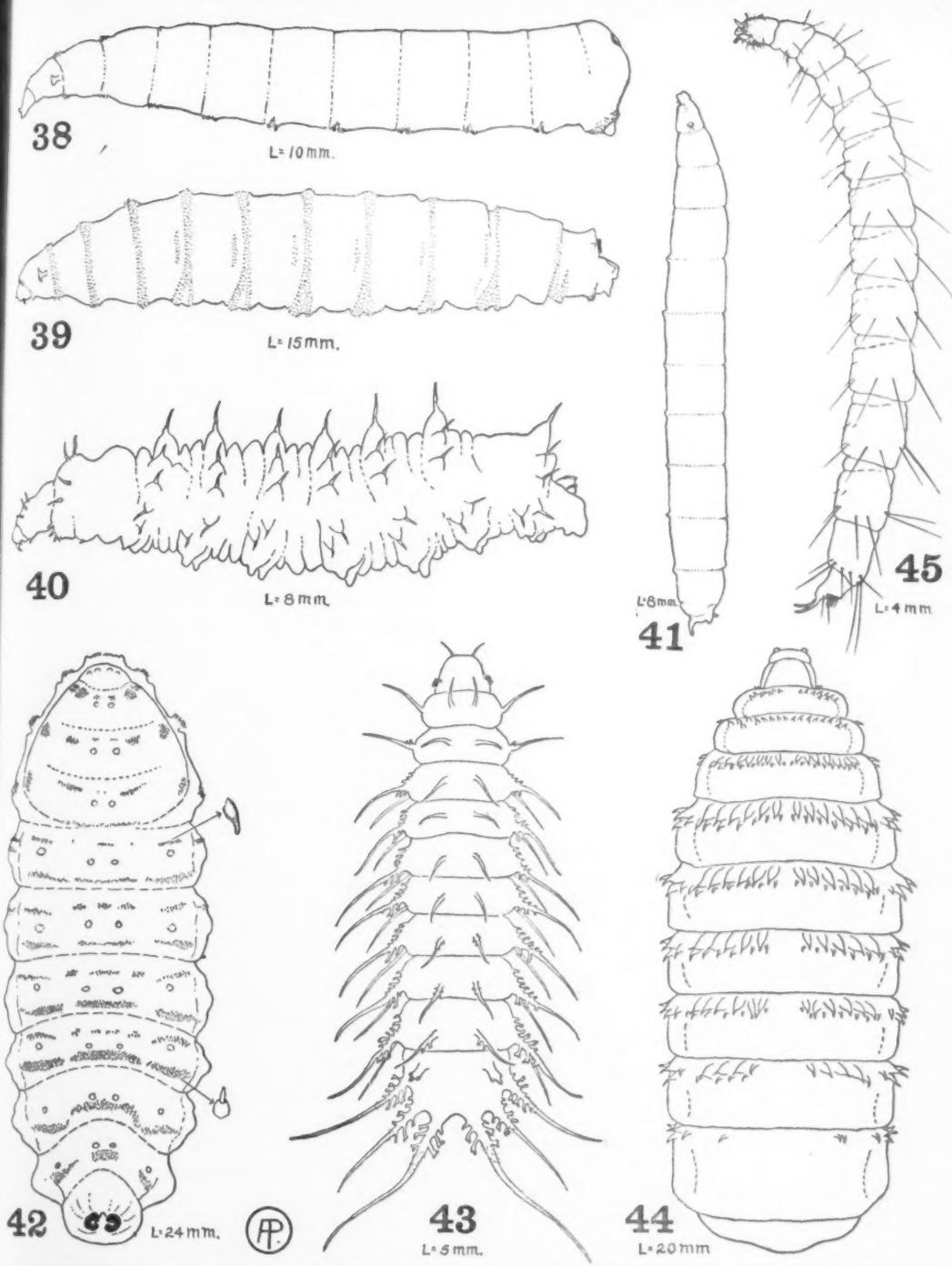
Beetle larvae also have unusual and interesting habits. A few will be mentioned. Among aquatic species the larvae of diving beetles (Fig. 14), water-scavengers (Fig. 16), and whirligig beetles (Fig. 19) are predacious on other aquatic insects and animal life. The *Donacia* larvae (Fig. 17) live in

deep water with their spiracular spurs (sp. spurs) inserted into the basal portion of stems of large water plants (water lilies, etc.) from which they obtain their oxygen supply. Water-penny larvae (Fig. 18) are found on stones usually in running water. The illustrated small delicate haliplid larva (Fig. 15) lives among filamentous algae in shallow water. Among terrestrial species some of the tortoise-beetle larvae (Fig. 25) carry their cast skins and feces on their backs. Many beetle larvae live in wood. Some buprestids live in the cambium layer of trees, a good example being the flat-headed apple-tree borer (Fig. 24). Some wood-boring beetle larvae may live in wood for many years before they emerge as adults. For example, a dining-room table made of white oak produced a cerambycid adult eight years after it was purchased from a furniture store. Scolytid larvae produce unusual engravings in the hard wood under bark of many trees. Other larvae (powder-post beetle) live in dry, hard wood and are very destructive to lumber, especially wood used in the construction of such tools as hammers, axes, shovels, and gunstocks. One of the most unusual beetles is that of the lead-cable borer whose larvae breed in dead wood, while the adults frequently bore holes in aerial lead telephone cables, producing short circuits.

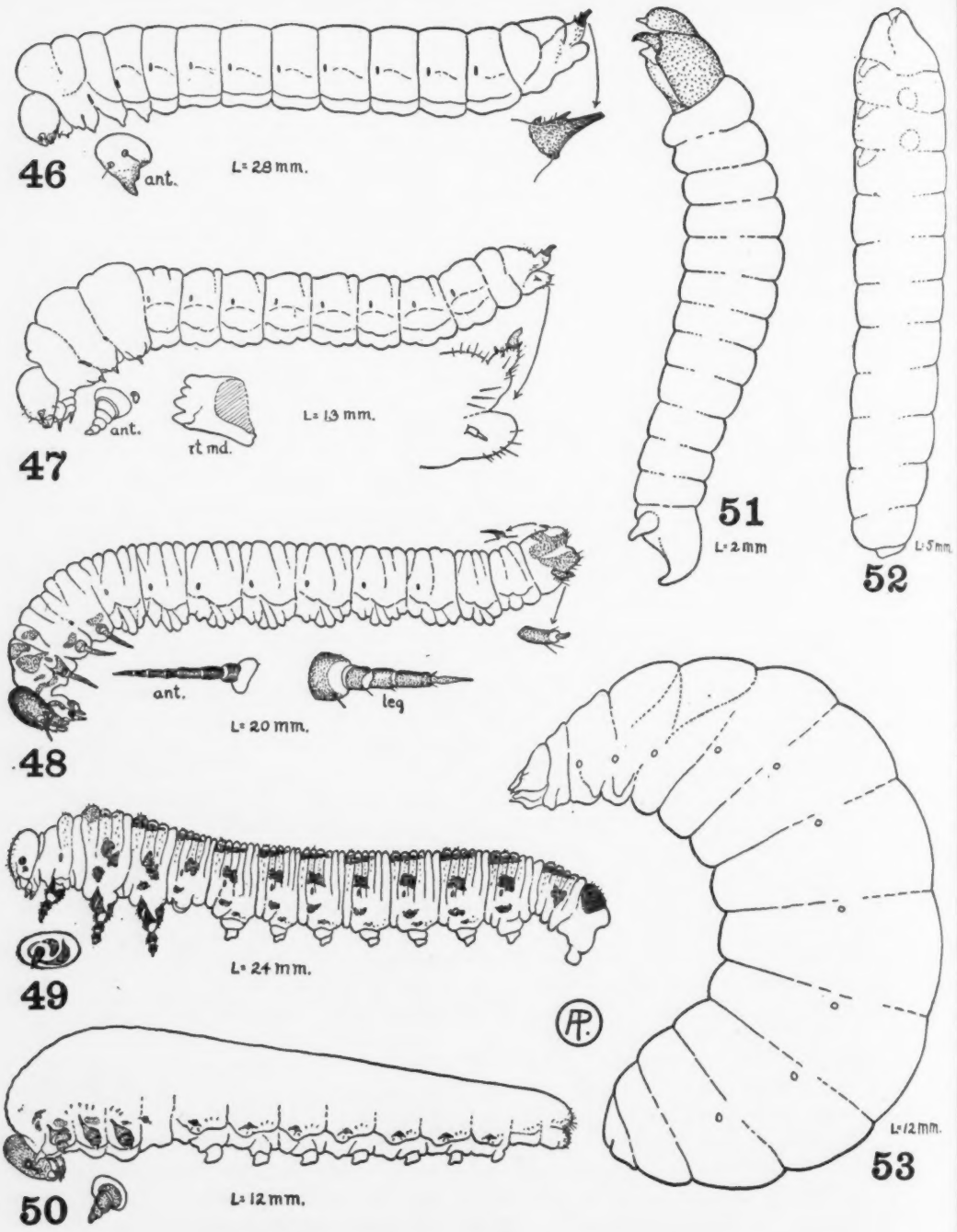
As we come to the discussion of the larvae of two-winged flies, such as mosquitoes, midges, and gnats (Diptera), again we find there is no common name for this group of larvae. Among the more specialized families, which include primarily species that are nonaquatic, the larvae are called maggots or worms, while among the more generalized and primitive species, which for the most part live in water, some of the larvae are called wrigglers. The larvae of various species of flies probably show a more decided variation in structure than any other order of insects. Figures 28–45 illustrate some of the common and unusual aquatic and terrestrial species. The greatest diversification in form occurs among aquatic species. Full-grown larvae of some aquatic species (crane flies, Fig. 34, and horse, or tabanid, flies, Fig. 33) may be 2 inches long. All these are frequently used as fish bait. They are the largest fly larvae we know, while the smallest full-grown forms are terrestrial species and approximate one-sixteenth inch long. In general most fly larvae are one-fourth to one-half inch long.

In the United States and Canada approximately 15,000 species of flies have been found. The larvae of very many are unknown or undescribed. Many more larvae of two-winged flies live in an aquatic environment than do larvae of the moths or beetles; in fact, close to 50 per cent of all flies spend their larval development in water, and many of the remaining species are submerged in semiliquid foods such as sap, fresh and decayed fruits, moist plant tissue, garbage, excrement, and blood.

One cannot present a general description for larvae of flies which will include most forms. The only character true to all species is the total absence of jointed legs. Prolegs also are usually absent, snipe-fly larvae (Fig. 35) being an exception. Also, a single or bifurcate appendage or proleg may occur on the first segment back of the head or at the tail end among a few aquatic species (Figs. 30 and 31). Swellings, enlargements, or roughened areas on the various segments, if present, help the larvae or maggots to crawl on or through the food they frequent. Many species of fly larvae are very smooth, naked, and without prominent structures which might serve in locomotion. Very few species possess hairs, spines, or scales. Some of the exceptions are the spiny larvae of the little house fly and the latrine fly (Fig. 43). Among many aquatic species, including some of the most primitive families, the larvae usually possess a distinct head (Figs. 30, 31, and 36) with chewing mouthparts or jaws that move from side to side. The larvae of more specialized flies (Figs. 38–44), mostly nonaquatic species, have no distinct head. The head end is pointed and usually possesses a pair of decurved, dark-colored mouth hooks which move up and down, not sideways. The mouth hooks serve as a rasping organ in feeding and also help to pull the larva through the moist medium it frequents. Breathing pores on a few terrestrial larvae are numerous and located on the prothorax and several abdominal segments. Among most aquatic species functional breathing pores are absent. Oxygen is obtained by



LARVAE OF TWO-WINGED FLIES (DIPTERA) AND A FLEA LARVA (SIPHONAPTERA) 38, COMMON HOUSEFLY MAGGOT (*Musca domestica* L.); 39, SCREWWORM OF DOMESTIC ANIMALS (*Cochliomyia americana* C. & P.); 40, SYRPHUS LARVA (*Baccha clavata* FAB.); 41, CHEESE SKIPPER (*Piophila casei* L.); 42, COMMON CATTLE GRUB OR OX WARBLE (*Hypoderma lineatum* (DE VIL)); 43, LATRINE-FLY LARVA (*Fannia scalaris* (F.)); 44, HORSE BOTFLY LARVA (*Gasterophilus intestinalis* (DEG.)); 45, DOG-FLEA LARVA (*Ctenocephalides canis* (CURT.)), A TINY, SLENDER, WHITE WORM WITH A DISTINCT HEAD.



LARVAE OF SAWFLIES, BEES, ETC. (HYMENOPTERA)

46, PIGEON TREMEX, A WOOD-BORING HORNTAIL LARVA (*Tremex columba* (L.)); 47, WILLOW-SHOOT SAWFLY LARVA (*Janus abbreviatus* (SAY)); 48, WILD-CHERRY WEB-SPINNING SAWFLY LARVA (*Neurotoma fasciata* NORT.); 49, RED-HEADED PINE OR LE CONTE SAWFLY LARVA (*Neodiprion lecontei* (FITCH)); 50, PEAR SLUG (*Caliora cerasi* (L.)); 51, NEWLY HATCHED *Macrocentrus* PARASITE OF THE ORIENTAL FRUIT MOTH; 52, FULL-GROWN LARVA OF THE SAME PARASITE; 53, FULL-GROWN HONEY-BEE LARVA (*Apis mellifera* L.).

tracheal gills or through the exoskeleton. Most of the maggots of the common flies with terrestrial habits have two pairs of breathing pores, an inconspicuous pair on the prothorax and a fairly conspicuous pigmented pair on the vertical face of the last segment (Fig. 42). Other species may possess only one of these pairs or none.

The food of the many species of fly larvae is highly variable. Among aquatic forms the larvae feed on living or dead plant tissue and on microscopic organisms, or they may be predacious, living on other insects and small arthropods. Among terrestrial forms many species feed within or on leaves, fruits, buds, stems, or roots of living plants. Some of these species produce marked malformations in plant tissue, commonly called galls. Many fly maggots are scavengers (Figs. 38 and 43), commonly found in all kinds of decayed plant tissue and also in the bodies of dead animals (blowflies, etc.). They also live in the excrement of various mammals (house flies, Fig. 38). Some species are parasitic on mammals, living in the wounds of cattle (screwworms, Fig. 39), while others complete their development in the intestinal tract (horse botflies, Fig. 44), or under the hide (common or northern cattle grubs, Fig. 42), or within the nostrils and head (sheep botfly) of domestic stock. Some maggots (tachinids) are beneficial to man because they live as internal parasites in larval and adult stages of many insect pests, and before they complete their development in the host they infest, the pest is killed. Other beneficial fly larvae (syrphus flies) are predacious and consume many plant lice and other insects. Dipterous larvae are commonly found also in nature in various kinds of fungi. One of the problems a mushroom producer faces is how to prevent certain fungus-loving flies from gaining entrance to his mushroom beds. Maggots are commonly found in a goodly number of preserved and prepared food products. A common example is the cheese skipper (Fig. 41) found in cheese or smoked ham or the blueberry maggot in preserved blueberries. Many eggs and tiny maggots may be present in our prepared and preserved fruits and foods. All of us have eaten unknowingly much insect-infested food without any ill effects. Perhaps the old adage "what we don't know won't hurt us" has some semblance of truth in it.

Fly larvae possess some unusual habits. For example, a species of *Miastor*, a tiny midge, appears to contradict a previous statement that all insects come from eggs or adults. Larvae of *Miastor* are able to reproduce themselves. Each tiny larva when full grown may have its body filled with many still smaller larvae. These eventually emerge, increase in size, and finally produce normal adult flies. *Miastor* larvae, when found under moist bark of fallen trees, may be present in dense sheetlike masses made up of thousands of individuals. Reproduction (paedogenesis) in the larval stage is an unusual phenomena for insects. Tiny moth-fly adults capable of penetrating average window and door screens may come from larvae living in the film of organic life about the stones of sewage filter beds. At times the flies emerging from these beds become so numerous that they are a distinct nuisance to anyone living near a sewage disposal plant. Black-fly larvae (Fig. 31) are interesting because they are found only in great numbers in swiftly running shallow water attached to stones, debris, and submerged vegetation. In spring they construct cone-shaped cocoons where the larvae are located, change to pupae, and emerge as adults in May or June. If you have ever been in the woods in Canada or the Northern United States where and when one or more biting species of black flies are abundant, you will always remember the harrowing experience. Other fly larvae living on or under stones in swiftly moving water are snipe-fly larvae (Fig. 35) and net-winged midge larvae (Fig. 37). Mosquito larvae (Fig. 36) and rat-tailed maggots producing syrphus flies (Fig. 29) breathe through an elongated tube which they project through the surface film, while soldier-fly larvae (Fig. 32), aquatic crane-fly larvae (Fig. 34), tabanid larvae (Fig. 33), and others breathe through spiracles located at the anal end which they project also above the surface film. Some aquatic larvae possess tracheal gills for breathing (Figs. 30 and 37).

If you possess a dog or cat infested with

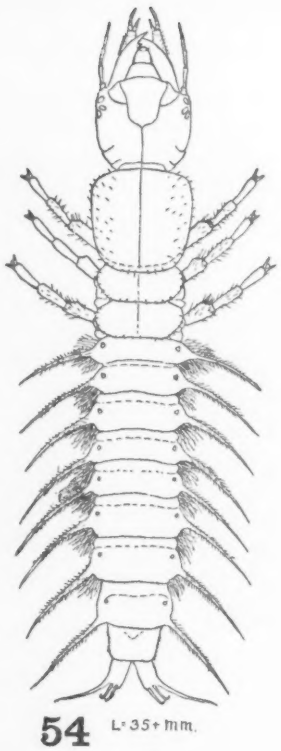
fleas you may not be aware of the fact that the immature growing stage of a flea is a larva. Fleas belong to the group of insects known as Siphonaptera, of which there are 260 species in the United States and Canada. Dog or cat flea larvae (Fig. 45) are usually found in or near the place where the house pet sleeps. A dog or cat flea larva is a tiny, slender, white worm with a distinct head. If examined under a microscope, a few long scattered hairs are seen on the several segments. The larva lives in and feeds upon cast-off animal debris and has no contact with the cat or dog. Eggs deposited by the adult fleas produce larvae. When the larvae are full grown they transform into light-colored, flattened (compressed) pupae which resemble mummified fleas. Previous to the emergence of the adult the general color of the pupa is very much like that of the dark adult. The time required for the completion of a life cycle depends largely upon the temperature of the environment. If the temperature average is low it may take six months or longer for a life cycle.

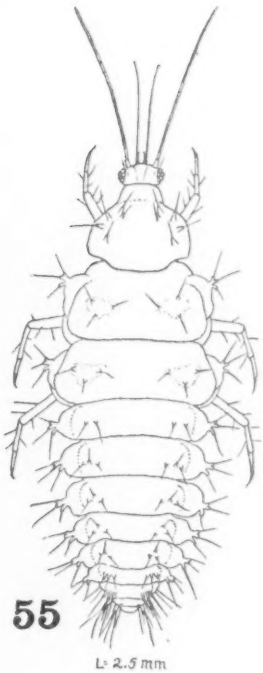
Some of the larvae of another large group of (Hymenoptera; 16,700 species), possessing four membranous wings, are illustrated in Figures 46–53. This order contains groups commonly referred to as sawflies, horntails, parasitic wasps, hornets, bees, velvet ants, ants, etc. Many of the larvae of the Hymenoptera live in nests or in cells constructed by the adults for their protection. Others are parasites living in or on various insects or other arthropods. The sawflies and closely related forms resemble many terrestrial insect larvae in that they feed on or within plants. Many typical sawflies (Fig. 49) resemble caterpillars in form and also feed on foliage; others are leaf miners or produce plant galls. Stem sawflies (Fig. 47) bore into the stems of plants or in tender shoots of trees and shrubs. False sawflies (Fig. 48), usually referred to as pamphilids or web-spinning or leaf-rolling sawflies, feed on foliage of trees and shrubs. They spin webs over the leaves or they roll over a portion of one leaf. These larvae are without prolegs but possess a pair of sharp-pointed subanal prongs. Horntail larvae (Fig. 46) bore within the trunks of many fruit and hardwood trees. They are legless, nearly white, cylindrical, elongated, and may possess a pointed anal segment.

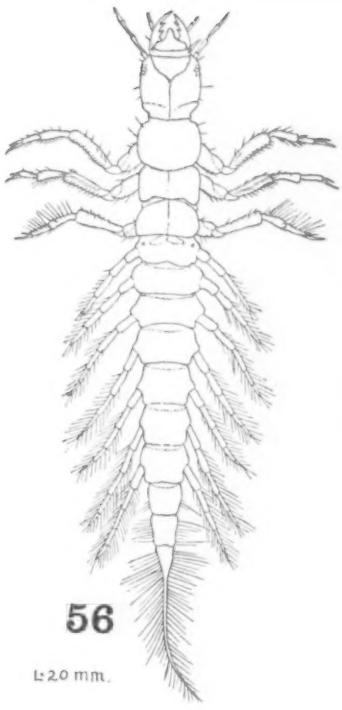
Typical sawfly larvae (Fig. 49) superficially resemble true caterpillars in structure, yet most species are readily distinguished. By means of a hand lens a fairly conspicuous single, simple eye may be seen on each side of the head in contrast to a crescent-shaped distribution of four to six simple eyes typical of true caterpillars. Also, seven or more pairs of fleshy prolegs without hooks are usually present on abdominal segments 2 to 7 and 10 in contrast to five pairs of prolegs with hooks on segments 3 to 6 and 10, which are typical of most true caterpillars.

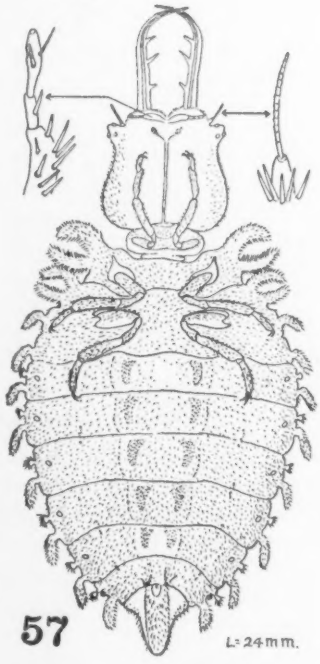
The larvae of nonplant-feeding species, where the adults prepare the nests and cells and also provide food for the development of the larvae, are usually fleshy grubs (Fig. 53) resembling fat curculio larvae. Many species do not possess a well-defined, conspicuous head. The mouthparts may be reduced to two opposable sharp jaws or fleshy lobes. These larvae are saclike, sometimes faintly segmented, and possess a mouth opening at one end and an anus at the opposite end. Inconspicuous breathing pores are usually present on most segments. The larvae of the numerous parasitic species may vary considerably in their first instar, which hatches directly from the egg. They may have a distinct head (Fig. 51) with opposable sharp jaws, special body structures used in locomotion, and a characteristic shape. Most of these larvae when full grown after three to five instars undergo a decided change. They may have an indistinct head with the mouthparts reduced to fleshy lobes. All organs of locomotion are lost and in general their shape may be elongated (Fig. 52) or resemble the legless saclike larva of a honey bee (Fig. 53).

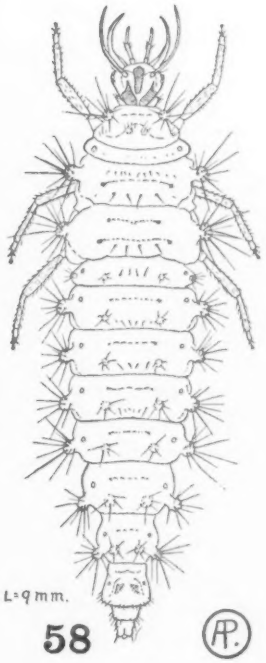
Some of the most unusual larvae occur among species that are parasitic on other insects. For example, the most important parasite of the codling moth of apples deposits its eggs in the host egg. The parasite egg hatches and the first instar establishes itself in the host embryo. The host egg hatches and the parasite completes its development within or on the codling-moth larva. When the host larva is about one-half grown the parasite larva emerges from the host and

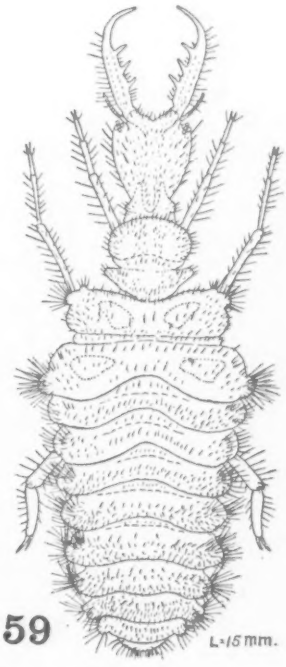












LARVAE OF NERVE-WINGED INSECTS (NEUROPTERA)

54, HELLGRAMMITE OR DOBSON-FLY LARVA ONE-HALF GROWN (*Corydalus cornutus* L.); 55, SPONGILLA-FLY LARVA (*Climacia* SP.); 56, ALDER-FLY LARVA (*Sialis* SP.); 57, ASCALAPHID LARVA (PROBABLY SPECIES OF *Uluodes*); 58, APHIS-LION (*Chrysopa nigricornis* BURMEISTER); 59, ANT-LION (*Myrmeleon* SP.).

completes the destruction of the host as an ectoparasite. It then spins a cocoon and eventually emerges as a tiny black wasp (*Arcogaster carpocapsae*). Other parasitic species may live their entire larval lives attached to the exterior of a beetle grub. Good examples of this habit are illustrated in the two most important introduced parasites of the Japanese beetle—*Tiphia popilliavora* and *T. vernalis*. Many other fascinating and unusual facts about larvae of parasitic species and other Hymenoptera could be presented.

The larvae illustrated in Figures 54–59 represent a few of the common and unusual species of nerve-winged insects (Neuroptera; 275 species). The common names of these are hellgrammites or dobsons (larvae of *Corydalus* or fishflies), alder-fly larvae, spongilla-fly larvae, aphis-lions (lacewing-fly larvae), ant-lions, and ascalaphid larvae. Larvae of the first three (Figs. 54–56) live in water, while the remainder are terrestrial. All are predators feeding on insects or other animal life. Each possesses a distinct head bearing conspicuous mouthparts fitted for chewing or piercing and sucking. Hellgrammites (Fig. 54) and alder-fly larvae (Fig. 56) crush their prey by means of strong jaws, while the others have paired mouthparts so constructed that the liquid contents of the crushed or pierced host may be sucked into the mouth of the predator. Hellgrammite larvae live among rocks in swiftly moving water. When full grown they are 2 to 3 inches long. They are much sought after by fishermen for bait. Alder-fly larvae may occur in shallow and almost stagnant water; however, some species are found in shallow portions of small fast-moving streams. The larvae of spongilla flies (Fig. 55) are very small, about one-eighth inch long. They also live on stones in swiftly moving water or along wave-swept rocky shores where freshwater sponges are plentiful. By means of their long needlelike mouthparts they feed on the individual sponge organisms in a sponge colony.

Chrysopa larvae or aphis-lions (Fig. 58) are common on plants infested with plant lice. They also feed on insect eggs and small larvae. Ant-lions (Fig. 59) construct pitfalls in sand or loose dry soil and conceal themselves in the bottom of cone-shaped depressions where they wait for prey, ants or other insects, to come along. When an insect falls into the trap it is grabbed and consumed by the ant-lion. Ascalaphid larvae (Fig. 57) resemble ant-lions in their late instars; however, they do not construct pitfalls. They wait in ambush on the ground or elsewhere until a likely host appears. Their bodies may be more or less covered with debris.

Caddisflies (Trichoptera; 500 species), scorpion-flies (Mecoptera; 65 species), and other groups possessing larvae have not been discussed or illustrated in this article.

The foregoing story is extremely fragmentary in view of the hundreds of fascinating species to be found within a stone's throw to a few miles of almost any home. Perhaps however, it has awakened or stimulated your interest in insect infants, and you may wish to start a collection of your own. Armed with a collecting bag containing a few such common gadgets as forceps, a sturdy trowel, a large screw driver, a small hand ax, bottles and vials filled with killing solution and alcohol, and a few empty mailing tubes and tin pill boxes, anyone may sally forth and collect some of the species mentioned and many others every bit as interesting. If aquatic collecting is to be done one will need a substantial aquatic dip net, several sturdy hand sieves, large white enameled trays, and one or more large metal buckets and glass jars.

NOTE: All the accompanying drawings except Figures 51 and 54 were made from full-grown larvae. The length of each larva is expressed in millimeters.

THE PROBLEMS WE FACE IN NUTRITION

By FRANK G. BOUDREAU

THE nature and scope of the problems we face in nutrition in the postwar years and the role of science in solving them will all depend, to some extent, upon the kind of world organization that is set up by the United Nations. If the governments and peoples of the different countries are determined to make world organization a success, even if it entails some sacrifices on their part; if there is growing mutual confidence and a real desire on the part of the majority of governments to organize peace as well as to prevent war, there will be practically no limit to the scope of science in promoting human welfare through nutrition. If, on the contrary, governments and peoples shrink from the sacrifices necessary to cope with aggression, distrust one another and collaborate grudgingly in technical matters, we may look for less and less opportunity for science and scientists to perform a useful function, either nationally or in the world as a whole.

The projected international organization for food and agriculture, referred to hereinafter as the FAO, will, if successful, multiply the opportunities for science and for scientists who devote themselves to nutrition, food, and agriculture. And whether or not it is successful will depend in large measure on the use it makes of science and the extent to which it enlists the whole-hearted co-operation of scientists in these fields. While FAO must be intergovernmental in nature, I should like to see it rest upon the solid foundation of science and scientists as well as on the support afforded by the peoples of the world for whose benefit it will attempt to apply nutritional and agricultural science.

The first recommendation made by the Hot Springs Conference in regard to the machinery each government requires to achieve the aims of the Conference was that there should be in each country a national nutrition organization "composed of authorities in health, nutrition, economics and agriculture together with administrators and consumer's representatives, etc.," . . . and that it would be the duty of this organization to ascertain food consumption habits and the nutritional status of different sections of the population, in order to formulate and recommend to governments a sound food and nutrition policy. The aims of such a policy, according to the Conference, were progressive improvement of diets, the elimination of specific deficiency diseases and the achievement of good health. So that there should be no mistake concerning the kind of dietary improvement implied, the Conference declared that the measure of the extent to which food supplies should be increased, and of the character and extent of the dietary improvements is best provided by dietary standards or allowances based upon scientific evidence. Governments were asked to adopt, as the ultimate goal of their food and nutrition policy, dietary standards or allowances based upon scientific assessment of the amount and quality of food, in terms of nutrients which promote health.

The significance of these recommendations is that they are based on international experience. For it should be remembered that the international food movement first became an important force in the world when the Mixed Committee of the League of Nations published its final report in 1937. Nutritional and agricultural scientists had made immense progress in the advancement of our knowledge in these fields, but they had worked scientifically as well as administratively more or less in separate compartments. Brought together in the Mixed Committee and obliged to work with health authorities, economists, and administrators, they became convinced that this integrated approach was the only correct approach to the complex problem of nutrition. The Committee, therefore, recommended that national nutrition committees should be set up in each country, believing that sound food and nutrition policy could only be formulated when economic and social action was co-ordinated with the advancement of nutritional science. A distinguished French scientist said to me recently, "Before the war we thought that we could leave politics to the politicians and

work undisturbed in our studies and laboratories. The result was the fall of France. After the war scientists must sacrifice some of their time to public affairs." The organization of national nutrition committees or councils, nationally as well as internationally, will give many scientists valuable opportunities for public service.

Let us imagine that we are members of a national nutrition organization or council set up by the government to carry out the recommendations of the Hot Springs Conference. We are at once confronted by the task of ascertaining food-consumption habits and the nutritional status of different sections of the population.

Food consumption habits are best ascertained by family dietary studies. When we come to make use of the data obtained in these studies it is evident that some standard of reference is essential. Such a standard is provided by tables of so-called dietary standards or allowances in terms of nutrients. The history of the attempts to formulate such dietary standards is a long one, epitomizing the long history of the science of human nutrition. The first standard referred to the amounts and kinds of foods necessary to prevent starvation, that is to maintain life on the lowest possible level, among prisoners and the inmates of public institutions. Then the criterion of such standards became the prevention of recognizable deficiency states. Soon the progress of nutrition revealed that these deficiencies existed long before they could be recognized without the use of special methods. Moreover, experimentation began to reveal that animals which appeared normal and healthy on a diet which prevented all recognizable signs of deficiency might be materially improved in health, size, and length of life by more generous allowances. The first standards to give due recognition to this fact were the so-called optimum standards adopted by a committee of experts in nutrition set up by the League of Nations, in 1936. Recent rapid advances in our knowledge of nutrition have made it necessary to revise upward the League's dietary standards, and at present the most widely used tables of dietary allowances are those of the Food and Nutrition Board of the National Research Council. All such standards have certain shortcomings due to gaps in our knowledge. The first shortcoming is that no such tables can take into account the infinite variability of human beings. Every individual differs from all other individuals, and this variability goes very deep; it is not restricted to age, weight, activity, color, and race. All we can expect of dietary allowances is that they will furnish indications of the amount and kind of nutrients required by individuals classified into larger or smaller groups according to the more important of these factors, such as age, degree of activity, pregnancy, lactation, etc.

A more important shortcoming is that the evidence upon which these standards are based is incomplete and that it is derived chiefly from animal experimentation. Aside from public reluctance to authorize or to undergo such experimentation, studies on human beings present the difficulty that they are expensive and time-consuming; expensive because they must, to be accurate, be subject to rigid control; time-consuming because of the length of the human cycle. Some nutrition authorities argue that certain animals are more suitable than man for such studies because of their shorter life cycle, and the fact that they can be readily controlled. According to these authorities, the results of certain of these studies on animals can be applied without hesitation to human beings, since the laboratory rat, for instance, is less susceptible than man to improvement in health by dietary means. I must emphasize, however, that even if we base dietary allowance solely on animal experimentation, the evidence available is still incomplete.

The war has stimulated a considerable number of human studies. These have necessarily been short-term studies, and what is needed is knowledge of the influence of dietary factors over the whole of the life cycle. A professional colleague of mine told me of a woman who, because of an oesophageal stricture, limited her diet to milk for a period of ten years. She came to the clinic with acute anemia and scurvy. But the interesting fact is that the scurvy did not develop until she had been on that diet for more than seven years. There is little ascorbic

acid in milk and much of what little it contains is destroyed by pasteurization. Hence one might have concluded, before the seventh year, that the small amount of ascorbic acid present in milk was all that is needed. It follows that short-term human studies to determine dietary requirements may be definitely misleading.

I suggest this field as a fruitful one for postwar study and experimentation; study of human beings as well as of animals which should be co-ordinated to the extent necessary to ensure that adequate consideration is given to all of the known nutrients. It would also be desirable to ascertain whether climatic and racial factors influence nutritional requirements. A good many people assume that these must differ in the different parts of the world and among the different races. So far as I know, there is no real foundation for that belief. The foods which people consume to satisfy their hunger may and do differ widely in different parts of the world, but no one has shown that this is also true of the essential nutrients.

As our knowledge of the different nutrients increases, tables of dietary standards or allowances must change correspondingly. As regards the vitamins, the tendency has been upwards. Studies are now being made to determine human requirements of the essential amino acids, and the results of these studies should help us to make better use of our protein foods. Since these tables are to be used as a guide to production or import, food scientists should be aware that small changes in the allowances may have important economic consequences.

Now that we have adopted tables of daily allowances, our next step is to analyze the data from the family dietary studies to see whether these diets are adequate for health. The first obstacle we encounter is the lack of accurate information on the composition of food. For the nutrient content of food varies enormously with a whole series of factors. If a number of analyses have been made of a particular foodstuff for a particular nutrient, we can take an average value. But there is very evident need for further work in this field, to improve methods of analysis and to increase the data available. Foods lose nutrients in storage, processing, and cooking; losses which must be taken into account. The Committee on Food Composition of the Food and Nutrition Board has undertaken, and to some extent carried through, an enormous amount of work to obtain accurate values on the composition of raw, processed, and cooked foods. Much additional work is needed in this field.

Now that we have compared our dietary studies with standards of dietary requirements we decide to compare the results with those of dietary studies abroad, and we find to our dismay that they are not comparable. When the principal United Nations decided to pool their food supplies for victory, it was a great triumph for reason. But when the time came to work the idea out in practice, it was found that the aim could not be achieved until more complete and more comparable information was available on the rates of consumption in the countries concerned. The three countries used different nutrient conversion factors, and the joint committee which prepared the report for the Combined Food Board remarks, "Even if two or more countries prepare estimates by the same basic method, considerable differences may arise as a result of divergent treatment of such matters as the scientific basis of calculating nutrient values, the point of distribution at which supplies are measured and the coverage of the statistics."[1]

Experience in the League of Nations has shown that the scientists in each country will cling firmly to their own methods until they are persuaded, by sitting down with foreign scientists on committees and by working out common problems together in the laboratory, that other methods might be preferable. Here is a whole field of useful work for food scientists in the different countries. The League has already made a beginning as regards the comparability of dietary surveys, and the standardization of certain vitamins which have not been synthesized. The research institutions of Canada, the United Kingdom, and the United States of America are beginning to co-operate together to secure agreement in matters of food composition and nutrient conversion factors.

Dietary studies provide valuable informa-

tion to guide the National Nutrition Council in formulating policy, but something more is needed; it is necessary to appraise the nutritional status of the population. Insufficient intake of ascorbic acid may cause scurvy, but the dietary study may not reveal such low intake because the loss of ascorbic acid in storage, processing, or cooking has not been taken into account. Moreover, a number of conditions, such as infections, may increase the body's need for particular nutrients, or they may be taken in with the food but not absorbed because of some pathological condition in the alimentary canal. Hence, to the physician, dietary studies are of chief importance in revealing whether a given nutritional deficiency is of dietary origin rather than as a means of appraising nutritional status.

Difficulties in the appraisal of nutrition depend upon the degree of departure from nutritional health it is desired to measure. No difficulty is experienced when malnutrition has reached the stage of an acute deficiency disease, such as scurvy or rickets or beriberi. The smaller the departure from the normal the more differences of opinion arise. Physicians who appraise nutritional status may take the stand that nothing less than the existence of the classical signs of full-blown deficiency diseases warrant a diagnosis, while others at the opposite pole hold that slight departures from average height and weight for age or slight eye, mouth, and tongue lesions are presumptive evidence of specific nutritional deficiencies. The physician in practice is rightly cautious and conservative; he has learned to be skeptical concerning cures alleged to have been effected by new drugs and he sticks to this attitude in the case of nutrition. The public health officer with medical training is inclined to believe that if the nutritional status of groups, however healthy, can be measurably improved by added nutrients, such as milk, it would not be unreasonable to believe that such a group had been undernourished. No one will dispute that it is desirable to measure milder and milder degrees of under- or malnutrition and to commend the work of those who have undertaken this difficult task.

The worker who wishes to appraise the status of nutrition has a whole series of methods at his disposal. I have already spoken of dietary studies. The others may be classified into anthropometric, biochemical, and clinical. Clinical methods include the use of the X-ray, the electrocardiograph, and the biomicroscope. Practically all of these methods have their shortcomings. I attach most importance to clinical judgment which, if based on experience and skill, will make the best use of all the methods employed.

I have no hope that a simple method of appraisal will ever be fully satisfactory, for there are too many factors in the complex of malnutrition. Nor do I believe it will be easy in the future to obtain general acceptance of any method or methods by which we attempt to measure minor departures from the normal. On the other hand, I believe it is possible to appraise nutritional status now better than ever before. However, a vast amount of work remains to be accomplished in this field which presents unlimited opportunities for the physician with special training and experience in nutrition and public health. Naturally such a physician needs the co-operation of many others, including the public health worker, the biochemist, the nutritionist, and the statistician.

If the work of United Nations Rehabilitation and Relief Agency (UNRRA) is to be successful in providing proper food for the undernourished in Europe, its efforts should be guided by authorities in nutrition. Dr. Harold Stuart of Boston, who has had considerable experience in this field, states, "All large scale relief feeding programs should [therefore] be preceded by a nutritional survey, and follow-up surveys should be repeated from time to time to keep abreast of changing conditions."[2] He recommends a complete mobile survey unit with a pediatrician who has had special experience both in nutrition and public health in charge (he is here concerned with the relief feeding of children), assisted by a medical assistant, a public health nurse, a nutritionist, one or two laboratory technicians, and an X-ray technician. He implies that surveys carried on by such a unit, according to methods of

which he gives a general outline, would be a guarantee that the most intelligent and scientific use had been made of funds contributed to meet the needs of an undernourished population. Everyone with experience in this field will agree with Dr. Stuart and will hope that UNRRA will not overlook this opportunity. That it is an opportunity not only to guide relief feeding but also to advance our knowledge of nutrition is evidenced by the work of Harriet Chick and her associates in Vienna after the first World War.

Now that the National Nutrition Council has ascertained food-consumption habits and appraised the nutritional status of sections of the population, its next task is to formulate policy and make recommendations to the Government. This means, in the words of the Mixed Committee on Nutrition of the League of Nations, "the interpretation of the general rules of rational nutrition in the light of national conditions. These general rules are necessarily in terms of calories, proteins, vitamins, minerals, etc. It is an important function of the National Committees to translate these into terms of specific foods, having due regard to the alternative sources from which the different nutrients can be obtained, the consumption habits of the people, the character of national and local production, the prices of the various foods, etc."[3] This is an essential part of the new science of food management in which the chief belligerent countries have accumulated so much valuable experience during the war.

Let us see how this work might increase the need for science and scientists.

Food management may be defined broadly as the science of making the best use of actual and potential food resources for human nutrition. Yields of vegetables and fruits have been increased through breeding, selection, and improved cultural practices. Genetic, soil, and climatic factors all influence the nutritive value of food crops. By proper selection the ascorbic content of the tomato may be greatly increased. This is also true of the thiamin content of wheat. This field, just now opening up, presents countless opportunities for science. In addition, much can be done to safeguard the nutrients in food by research into storage, processing, and cooking. Practically all of the ascorbic acid and much of the thiamin in food may be lost by improper methods of cooking. The Royal Canadian Air Force found that the daily ration as cooked contained from 0 to 20 or 30 milligrams of ascorbic acid, whereas the ration before cooking was known to have an average ascorbic acid content of 115 milligrams. We need to know first what happens to different foods in storage, processing, and cooking, and second what are the best methods of storing, processing, and cooking in order to conserve nutritive value. This looks like the plainest kind of applied research and might be regarded as almost beneath the dignity of food scientists. I would make a plea for viewing it from a higher plane. A direct attack on the problem may yield less valuable results than a more fundamental approach. What is needed is thorough study of foodstuffs, viewed as biochemical systems, by the food scientist who has no useful or practical end in view, but simply a consuming curiosity about the nature of food.

There are ways of improving the nutritive quality of foods other than those I have mentioned. Bread may be improved by being made of a higher extraction flour: 80 per cent or 85 per cent as opposed to the usual 70 or 72 per cent. This method has been used in the United Kingdom and Canada. Losses of nutrients in processing may be made up by enrichment, or fortification. Examples of this are: additions of iodine to salt and of thiamin, riboflavin, niacin, and iron to flour and bread, as is done in the United States of America. Enrichment, or fortification, may also be used in cases in which the nutrients have not been lost in processing but in which it may be desirable to provide a nutrient which is generally deficient in the food supply of large groups. Examples are the addition of vitamin A to margarine, the addition of vitamin D to milk, and the addition of vitamin C to apple juice. The latter practice is limited to Canada.

The Joint Committee set up by the Combined Food Board to study food consumption levels in the United States, Canada, and the United Kingdom, found that "Canadian in-

take levels [of ascorbic acid] would certainly fall below even the restricted requirements" [70 per cent of the National Research Council's allowances] "if losses occurring in storage, marketing, preparation, and cooking were taken into consideration."[4] It is, therefore, reasonable for the Canadian authorities to add ascorbic acid to a fruit juice in which it is presumably fairly well preserved. It should be remembered that the advance of nutritional science has made it possible to produce a number of important nutrients in pure form and that in this form, when the demand is sufficiently great, they are very cheap, cheaper than they can be produced in food. Is it too much to ask that the possibility of enriching foods by this economical means should be given full consideration by national nutrition authorities? No change in food habits is involved in this method so that good may be done by stealth. Millions of Americans have in all probability received considerable benefit from the enrichment of white flour and bread, whereas educational efforts over long years had failed to increase appreciably the consumption of whole wheat bread. In Canada approved flour and bread have not found more general acceptance in spite of being favored by the authorities during a period of war emergency.

Efforts are now being made by the Cereal Committee of the Food and Nutrition Board to encourage the enrichment of corn products with niacin, in which this cereal is deficient. Rice is the classic example of a cereal which is incomplete nutritionally in the usual form in which it reaches the consumer. Where the custom is to parboil rice beriberi does not prevail, for by this process the vitamins in the outer layers penetrate all parts of the berry and cannot readily be removed in preparing rice for the table. Undermilling and enrichment are other methods of making rice a more valuable food nutritionally, but neither undermilled nor parboiled rice are acceptable to the majority of rice eaters. Here, then, is a golden opportunity for the food scientist, for success in this field may banish the ravages of beriberi from vast populations.

There are other methods of enhancing the nutrient value of foods to which reference must be made since these furnish opportunities for research by the food scientist. These were referred to by the Hot Springs Conference in the following words:[5]

> There are many methods of preparing foods followed by peasant peoples, especially those living mainly on foods of vegetable origin, the importance of which in the nutrition of the consumer are at present scarcely appreciated and little understood. In particular, reference may be made to the enhancement of the nutritive values of grains, legumes, and other vegetable products, following soaking and germination and the growth of microorganisms, such as yeast and molds. More research is needed on the problem of how such methods affect the composition of diets as consumed.

National nutrition may be improved by changes in food habits. Enforced changes in food habits have been common in this war. A good example is the acceptance by the British people of the national wheat meal loaf of 85 per cent extraction flour. In this country, in spite of widespread and long-continued education in the value of such bread as compared to white bread, there has been practically no increase in its consumption. I, therefore, venture to believe that the people of Britain will demand a return to white bread after the emergency is over, thus illustrating the difficulty of changing food habits.

Food habits vary from country to country, and are most difficult to change where the general level of public education is low. It is particularly difficult to improve the food habits of the lowest income groups, for they are limited to the cheapest foods, and the greatest concentration of valuable nutrients is found in such expensive foods as meat, milk, eggs, fruit, and leafy green and yellow vegetables. In the words of the Hot Springs report: "Poverty almost invariably means a poor and insufficient diet, and the latter is the main cause of the disadvantage of the poor in respect of health, so clearly shown by statistics of disease and mortality."[6]

The Hot Springs Conference had this to say of food habits: "Traditional dietary practices are supported by the whole cultural complex of attitudes toward social class, religion, the rhythms of work and rest periods, the education of children and formalized social ties between persons and groups."[7]

The basis of these attitudes must be understood if we are to succeed in influencing in a desired direction the pattern of food habits. What we have to seek, according to a recent writer,[8] is the point at which social preferences are most readily influenced. This he believes to be the school canteen. The value of the industrial canteen, as an educational force, has been revealed in this country during the war.

This is a complex subject on which a great deal could and has indeed been said. As far as our national nutrition organization is concerned, I suggest that all recommendations for improving diets should take into account prevailing food habits; that as much improvement as possible should be effected without altering food habits; that the success of efforts to change food habits depends in the first instance on the general level of education; that the lower the level the more difficult to effect changes; and that school lunches and industrial canteens present favorable opportunities for education in better nutrition.

As a final word on this subject, may I emphasize that no one should make the mistake of believing that the diets of the lowest income groups are necessarily based on food habits or preferences. When income increases, these people, as a rule, purchase more of the more nutritive foods. This favorable change in food consumption is apparent during every period when there is full employment and increased earning power.

There are many more problems and opportunities for science in the field of nutrition during the postwar years. According to Lord Horder,[9] "[But] we must remember that the science of nutrition is a young science with, as yet, but a few established and accepted facts by comparison with those which may reasonably be expected as the science extends in depth and breadth." The speed and scope of this extension will depend upon two factors: How fundamental is the approach of research workers and how adequate is the supply of properly trained workers?

Much of the nutrition research now being published is of little fundamental value. This may be inevitable, for many wrong trails must be explored before the right one will be found. But I have the conviction that better training of workers would greatly increase the value of the research being carried out.

The Conference at Hot Springs recommended that governments should initiate or continue the study of the relationship between malnutrition and impaired bodily health and vigor; and, in particular, investigate the role of inadequate food consumption in the causation of, and mortality from, all those diseases which constitute their most serious health problems, and "direct their attention to the study of health and well being and of the nutritional and related factors which are necessary to secure and maintain them."[10]

Although it has been known for centuries that famine is almost invariably followed by pestilence, science has not fully elucidated the role which nutrition plays in immunity or susceptibility to disease. Nutrition deficiencies apparently cause decreased resistance to certain types of infection. In animals deficient in protein, production of antibodies seems to be impaired. Cottingham and Mills have shown that deficiencies of thiamin, riboflavin, pyridoxine, pantothenic acid, choline, ascorbic acid, and proteins diminish phagocytic activity. Many other contributions have been made, but much further study is needed. Here is a fruitful field for research after the war.

Another field of opportunity for science has been opened up by Warkany who has shown that a grain-deficient diet fed to rats will produce bony deformities in a large proportion of the offspring.

Williams, Wilder, and their associates have studied and reported on the results of controlled studies of human beings consuming diets deficient in thiamin and riboflavin. These results have been so challenging as to stimulate many similar studies.

The present obstacle to further progress, both in research and in the application of its results, is the lack of workers with the necessary technical training and experience. I imagine that many more workers are needed in biochemistry and physiology. But the greatest need, as I see it, is for workers who have received fundamental training in all

the branches of this complex subject. Specifically, the need is for physicians with special knowledge of biochemistry, the physiology of nutrition, the clinical aspects of nutrition, and public health. There is also need, as I have indicated, for food scientists who have been trained in all the aspects of food, just as the specialized physician should be trained in all the aspects of human nutrition.

Finally, scientific workers are needed to make the best use of the vast accumulation of useful experience during the war, when great populations have been subjected to various types of deficient and improved diets, and the new science of food management has come into its own.

If the FAO is to succeed research must be one of its principal functions, for only by research will it be able to solve the nutritional problems of the peoples of the world. This applies equally to the national nutrition organizations which governments are to set up, each of which should have an advisory research committee.

"Preventive action against such nutritional diseases as scurvy, rickets and beriberi, although superficially more impressive, is probably of less importance to the human race than the acquisition and application of such knowledge as will also improve the general condition and well being of every man, woman and child, through the better choice, provision and utilization of foodstuffs."[11] By removing through research the obstacles which stand in the way of progress along this line, science and scientists will open up entirely new perspectives for the improvement of human welfare.

References

[1] Food Consumption Levels in the United States, Canada and the United Kingdom. (Report of a special Joint Committee set up by the Combined Food Board, p. 17, section 20.) Issued by United States Department of Agriculture, War Food Administration, April 1944. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price, 20 cents.

[2] *Nutrition Reviews*, Aug. 1944, Vol. 2, No. 8, p. 225.

[3] Mixed Committee of the League of Nations. The Relation of Nutrition to Health, Agriculture and Economic Policy. Final Report. Series of League of Nations Publications, Geneva, 1937, pp. 36–37, section 13.

[4] Ibid. p. 42, section 80.

[5] United Nations Conference on Food and Agriculture, Hot Springs, Virginia, May 18–June 3, 1943. Final Act and Section Reports. Report of Section 1, p. 44. United States Government Printing Office, Washington 25, D. C., 1943. Price, 25 cents.

[6] Ibid. p. 35.

[7] Ibid. p. 46.

[8] Clark, F. Le Gros: Food Habits and How to Change Them. *The Lancet*. July 8, 1944, pp. 53–54.

[9] Horder, Lord: Cautious Food Reform. (Extract from Lord Horder's presidential address to the Food Education Society on June 24.) *The Lancet*. July 8, 1944, p. 53.

[10] Ibid. Recommendation V, p. 14.

[11] Mixed Committee of the League of Nations. The Relation of Nutrition to Health, Agriculture and Economic Policy. Final Report. Series of League of Nations Publications, Geneva, 1937, pp. 83–84.

A NEW INHERITED HUMAN VARIATION, THE RH BLOOD FACTOR

By HERLUF H. STRANDSKOV

No INHERITED human variation has ever been the center of more interest among human geneticists and clinicians than the recently discovered Rh blood factor. Over a hundred scientific papers dealing with some aspect of its characteristics and importance have appeared in the short span of four years since its discovery.

Before discussing the Rh blood factor a few immunological facts may be reviewed. When a foreign microorganism or a chemical substance from a foreign organism is introduced into an animal, the tissues of the latter may develop chemical substances (antibodies) which tend to counteract or destroy the foreign substance. This is the basis for all acquired immunities to infectious diseases. Blood of every animal contains certain specific chemical substances (proteins, etc.) which differ from one to another, especially if they are distantly related. Therefore, when the blood of an animal of one species, for example, species A, is injected into the system of an animal of species B, the tissues of the latter will develop antibodies (agglutinins, etc.) against the blood factors of the former. This can be demonstrated by adding a drop of blood serum from an animal of species B, which has been immunized against A, to a drop of blood from an animal of species A. The reaction which occurs is a clumping, or an agglutination, of the red blood cells of animal A.

A few years ago Landsteiner and Wiener were injecting blood from the rhesus monkey (*Macaca mulatta*) into rabbits with the hope of developing in the rabbit a serum which would react with some then unknown human blood factor. This was not an unreasonable hope because the rhesus monkey is not very distantly related to the human species, and therefore might be expected to possess some factor in common with man. The interesting fact is that in 1940 these two investigators did obtain a new anti-rhesus blood serum from immunized rabbits which, when added to human blood, agglutinated the red blood cells. This meant, of course, that a new human blood factor had been discovered. Since rhesus monkey blood had been used for the development of the serum, they called the new human blood antigen the Rh blood factor. Rh is, of course, an abbreviation of rhesus and reminds us that this human antigen must be identical with, or at least similar to, one found in the rhesus monkey.

Although Landsteiner and Wiener had found that the new serum agglutinated the blood of human individuals they soon discovered that this was true only for the blood of some human individuals and not for that of others. For instance, among members of the White, or Caucasoid, stock they found that only about 85 per cent of all individuals possess the new Rh factor, or are Rh positive, and that the remaining 15 per cent do not possess it, or are Rh negative. (Later we shall indicate why these frequencies are applied specifically to Caucasoids.)

When a variation such as the presence and absence of the Rh blood factor is discovered in the human species, or in any other species for that matter, it becomes of interest to find out if it has any hereditary basis. In 1941 Landsteiner and Wiener reported the results of a genetic study which involved 60 families with 237 children. On the basis of these results these two investigators concluded that Rh variations are completely genetically determined and that they involve a pair of autosomal genes with *dominance* relationships. The dominant gene they appropriately designated *Rh* and the recessive *rh*. According to their conclusions an individual is Rh negative if he is pure or homozygous recessive *rh rh*, and Rh positive if he is homozygous dominant *Rh Rh*, or heterozygous *Rh rh*. (The term autosomal implies that the two genes are not located on the sex

chromosome pair, but on one of the other 23 pairs of chromosomes or autosomes, as they are called.) When the genes which are responsible for a variation have their locus on an autosomal pair of chromosomes, the variations which are involved have the same frequencies among females as they do among males.

In 1943 Wiener and Sonn extended the Rh genetic study to include 40 additional families with 138 children. Hence, a total of at least 100 sets of parents and 375 children have been tested. The results of the second family study supported the genetic conclusions drawn on a basis of the first.

Recently Strandskov and Diederich tested the genetic conclusions of Landsteiner and Wiener by examining for the Rh factor among 39 pairs of identical (monozygotic) and 43 pairs of fraternal (dizygotic) twins. They found that the two members of the 39 pairs of monozygotic twins were in every instance of the same Rh blood type; that is, either both Rh positive or both Rh negative. Since monozygotic twins have identical genetic compositions, this perfect concordance among monozygotic twins with respect to the Rh factor lends credence to the conclusion that Rh variations are completely genetically determined. It is important to be sure of this conclusion if Rh variations are to be used as evidence in legal cases of disputed parentage or as criteria for the determination of type of twin set. Without presenting the result obtained among the dizygotic twins we may mention that the frequencies of the different possible Rh combinations among them support the mode of inheritance of the Rh factor suggested by Landsteiner and Wiener.

Within the last year or two evidence has been obtained that the Rh factor has subdivisions and that these also have a hereditary basis. Although this is true, the general mode of inheritance suggested by Landsteiner and Wiener, and presented above, may still be considered basically correct.

To clarify the general mode of inheritance of the Rh factor we shall present the six possible Rh matings which may occur in a population and also the results which may be expected among their offspring.

Mating	*Expected offspring results*
1. Rh Rh × Rh Rh	= 1 or all Rh positive
2. Rh Rh × Rh rh	= 1 or all Rh positive
3. Rh Rh × rh rh	= 1 or all Rh positive
4. Rh rh × Rh rh	= 3/4 Rh positive: 1/4 Rh negative
5. Rh rh × rh rh	= 1/2 Rh positive: 1/2 Rh negative
6. rh rh × rh rh	= 1 or all Rh negative

The expected types of offspring from a given mating may be calculated as follows: (Mating No. 4 above has been chosen as an example.)

Mating ♀ Rh rh × ♂ Rh rh

Eggs expected = 1/2 Rh: 1/2 rh

$$\text{Sperm expected} = \frac{\text{1/2 Rh: 1/2 rh}}{\text{1/4 Rh Rh: 1/4 Rh rh}}$$

Genetic or genotypic ratio

$$\text{expected} = \frac{\text{1/4 Rh rh: 1/4 rh rh}}{\text{1/4 Rh Rh: 2/4 Rh rh: 1/4 rh rh}}$$

Since the *Rh* gene is dominant over the recessive *rh* gene, the genetically expressed or phenotypic ratio expected from this mating is: 3/4 Rh positive: 1/4 Rh negative.

The frequencies of the several Rh matings in the population differ and are of importance in a detailed discussion. The important point here is that the mating frequencies within the Caucasoid population are such that about 85 per cent of the offspring of all the matings will be Rh positive and about 15 per cent will be Rh negative.

The story of the Rh blood factor would not be complete without refering to its relationship to a hemolytic disease of the fetus or newborn child, known as erythroblastosis fetalis. This disease has been known to the medical profession for many years, but prior to the discovery of the Rh blood factor no causal explanation of it was at hand. The disease is characterized: (1) by a swelling of the fetus due to a collection of fluids in its tissues (hydrops or edema); (2) by a yellowish staining of its integument and deeper tissues by bile pigments (jaundice); and (3) by a deficiency of blood or blood cells in its vascular system (anemia). Although a child may survive this hemolytic disease, it generally dies prior to or shortly after birth.

In 1941, following the discovery of the Rh factor, Philip Levine and his co-workers related erythroblastosis to the Rh blood factor. They postulated that the disease is due to anti-Rh antibodies (agglutinins) developed in an Rh negative mother which diffuse

through the placenta and react with Rh positive blood cells in the fetus to produce erythroblastosis. According to this hypothesis the disease appears only when a mother is Rh negative and when her developing child is Rh positive. According to them the whole series of events occurs as follows: (1) Red blood cells, or perhaps other cells of the Rh positive fetus, pass through the placenta into the circulating blood stream of the Rh negative mother; (2) in the tissues of the Rh negative mother the Rh positive antigens act as foreign substances and initiate there the formation of anti-Rh antibodies (agglutinins); (3) these antibodies in the mother's blood stream in turn diffuse through the placenta into the blood stream of the Rh positive fetus; and (4) in the fetus these antibodies (agglutinins) react with the Rh factor to produce the disease known as erythroblastosis.

Levine and his co-workers not only postulated these conditions and relationships, but actually demonstrated that Rh antibodies may be found in the blood stream of mothers of erythroblastotic infants. They also observed that most erythroblastotic fetuses are Rh positive and that most of their mothers are Rh negative. So convincing have been the results of their investigation, as well as those of others, that it is almost certain now that all cases of erythroblastosis may be attributed to the inherited Rh blood factor. The few seemingly exceptional cases which have been reported can now probably be explained satisfactorily. At least we may now say with certainty that well above 90 per cent of all cases of erythroblastosis, if not all, are due to the Rh blood factor.

There is a question of interest in the incidence of erythroblastosis. According to theory, and also according to observed facts, about 9 per cent of all Caucasoid babies are Rh positive and have an Rh negative mother. Thus, about 9 per cent of all babies are potential erythroblastotics. Fortunately the disease is not nearly this common. According to Potter and others, it occurs only in about one out of every 40 potential cases. Hence it occurs only in about one out of every 400 births.

Although only about one in forty of all potentially erythroblastotic babies develop the disease, it is true that if erythroblastosis has occured in a given family it will occur again in that family in subsequent Rh positive conceptions. If a husband is homozygous Rh positive (*Rh Rh*), then all subsequent babies in that family will be erythroblastotic. If he is heterozygous (*Rh rh*), then only one-half may be expected to develop the condition because then only one-half should be Rh positive. The other half should be Rh negative (*rh rh*), and an Rh negative child can not develop erythroblastosis.

It will be apparent from the foregoing discussion that erythroblastosis does not appear in some families which present the necessary Rh relationship between fetus and mother, that is, in which the mother is Rh negative and the fetus is Rh positive. Why the disease appears in some potential families and not in others is not known, but apparently the difference is one of placental development. Apparently some women have the tendency to develop defective placentae which permit red blood cells or other cells of the fetus to enter her blood stream. Only in families where the mother has this tendency does erythroblastosis occur, but once the disease has appeared, all subsequent Rh positive embryos with the same father will be erythroblastotic.

As indicated above, an erythroblastotic child occasionally survives birth. What, if anything, can be done for such a child? A blood transfusion may be helpful. If it is desirable to give a transfusion, the transfused blood should be that of an Rh negative individual because such blood contains no Rh antigen to be agglutinated, but it should not be that of its own Rh negative mother, because her blood contains anti-Rh antibodies, which would clump the red blood cells of the fetus and aggravate the disease. It has also been shown that other Rh negative individuals who have had Rh positive blood transfusions may have Rh antibodies in their blood stream. Therefore, blood from such individuals should not be used either.

Since the Rh blood factor is an inherited characteristic, the question is frequently asked if it would not be possible through

legislation to eliminate erythroblastosis from the human population. The answer to this question is, yes, this would be possible. The disease could be eliminated by prohibiting all Rh positive or all Rh negative individuals from marrying or from having offspring. If all Rh positive individuals were prohibited from having offspring erythroblastosis would be eliminated in a single generation, but who is going to ask 85 per cent of the population not to have children? If all Rh negative individuals were prohibited from having children, then many generations would be required, because some Rh positive individuals would carry the recessive gene, *rh*, and these recessive genes would continue to combine for many generations to produce Rh negative individuals. Again, it is not justifiable to ask 15 per cent of our population not to have children.

Erythroblastosis could also be eliminated by prohibiting Rh negative women from marrying Rh positive men, but again, it must be admitted that the frequency of occurrence of erythroblastosis does not justify even such a measure. The most that seemingly should be done at present is to acquaint everyone with the genetic and clinical facts which are known about the Rh blood factor, and especially to inform the parents of an erythroblastotic child of the probability of its recurrence within their family.

Earlier in this paper it was stated that the Rh positive and Rh negative frequencies which were indicated pertained specifically to the Caucasoid stock. This was done because Mongoloid and Negroid populations have been shown to have somewhat different frequencies. Such racial differences are also being found with respect to the subdivisions of the Rh factor. Because this is true, a thorough study of the Rh factor among different populations should contribute materially in the future to our general store of knowledge of racial differences, racial similarities, and racial interrelationships. A thorough study of the genetics of the Rh blood factor should also give us one more criterion which may be utilized in legal cases of disputed parentage and in the diagnosis of twins.

It was mentioned earlier that any Rh negative individual may develop anti-Rh antibodies if Rh positive blood is transfused into his or her blood stream. Since this is true, the Rh blood factor should also be considered in all ordinary blood transfusions. At least an Rh negative individual should never be given repeated transfusions of Rh positive blood, and an Rh positive individual should not be given blood from an Rh negative individual who has had Rh positive transfusions and therefore may have anti-Rh antibodies in his or her system.

As implied in some of the statements above, the story of the genetics and the clinical importance of the Rh blood factor has not been completely worked out as yet. Consequently, some of the opinions presented may have to be altered slightly as more and more facts are accumulated. Although this may be true, there is no question but what the basic concepts which have been presented are correct and will continue to stand.

GOOD WATER AND HUMAN LONGEVITY*

By W. S. MAHLIE

THROUGHOUT all ages the abundance and purity of water for human use have been of paramount importance. No civilization has flourished without an adequate water supply, and although it may not be directly responsible for human longevity, it is generally conceded to be a contributing factor. No matter where one begins his study of civilization he will always find evidence in the ruins of cities of well-developed water supplies, whether they were in the valley of the Euphrates and Tigris, in ancient Rome, or in Carthage.

As will be recalled, one of the troubles of the children of Israel in their wanderings was the lack of water and that Moses purified the bitter waters of Marah (Exodus 15: 25). Later Elisha at Jericho (2 Kings 2: 20–22) purified the waters by means of salt. In Solomon's words of wisdom (Proverbs 5: 15) he says, "Drink waters out of thine own cistern, and running waters out of thine own well," probably intending to convey the advice to shun water of unknown quality.

Perhaps the most famous of all ancient water supplies was that of Rome. Frontinus in his *Water Supply of Rome* gives a good description of the aqueducts existing at the time he was serving as water commissioner of the city (A.D. 96–98). Beginning in 312 B.C. and continuing to A.D. 226, nineteen aqueducts were constructed in Rome, having a total length of 381 miles.

Pliny (A.D. 70) speaks of the blessings conferred by the gods on the city of Rome in providing a bountiful water supply and says that the water from the Marcia Aqueduct was the cleanest in the world. Pliny also records that Agrippa in one year constructed 70 pools, 105 fountains, and 130 reservoirs.

After the Greek and Roman rise of civilization and the abundant use of good water in bathing and drinking, there followed a decline in civilization, and it is not surprising that in the Medieval period disease and superstition were prevalent. Many of the plagues which scourged Europe at that time probably were water-borne epidemics from contaminated water supplies.

Curative Waters. Just when man first realized the difference in quality of water is unknown. It takes no great imagination, however, to conceive that primitive man favored clear, sparkling, cool water from a spring, over that from a muddy creek or pool, and that as time went on he began to associate certain diseases with certain waters and, conversely, to utilize certain watering places to regain his health.

While we may smile at Ponce de Leon's search for the "Fountain of Youth," there are today many people going from one health resort to another searching for a water that will cure their ailments.

Natural healing waters are not so highly esteemed in our country as in Europe. There may be a number of reasons for this. The European waters have been used for a much longer time; the merits of American waters may have been overestimated; and again it may be that the privilege of a prolonged stay at those watering places is limited to the wealthy classes.

A great variety of opinion exists as to the benefits derived from so-called "curative" waters, varying from the expression "fake" to "miraculous." It is probable, however, that owing to dissolved mineral salts some waters do possess a therapeutic value, and this, together with the attendant change in climate, scenery, rest, social life, sports, and amusement found at these resorts, does often work an improvement in health.

Some waters may contain laxative salts, others may contain iodine, which benefits certain types of goiter, and recently it has been found that fluorine if present within certain limits retards tooth decay.

Much remains to be said of the "radium-bearing" waters. Radioactivity in waters was observed many years ago. In 1926 the U. S. Geological Survey reported that in order to produce detectable effects by drinking radioactive waters, 100 to 1,000 gallons

* Paper read before the Texas Academy of Sciences meeting, November 15, 1944.

would have to be drunk daily! In 1932 the City of New York Health Department tested a large number of commercially sold waters and found them to be entirely devoid of radioactivity. On the other hand, there are radioactive waters, the drinking of which is said by reputable physicians to be beneficial. Time, experience, and scientific research alone will decide this question.

Drinking Water and Disease. To correlate good water and human longevity with mathematical precision is a rather difficult if not impossible task, but it can be done in a general way by showing first the relationship between drinking water and disease and then the reduction in water-borne diseases resulting from improved water supplies.

Many of the great plagues and epidemics of the past probably were water-borne. Unfortunately this cannot be said with certainty, because it is only since about 1850 that the germ theory has been advanced and definite causes attributed to epidemics.

In the present day we recognize with certainty three principal diseases that are contracted mainly by drinking contaminated water. They are cholera, typhoid and the related paratyphoid, and dysentery, both bacillary and amoebic. These diseases are caused by specific organisms, introduced into the water from external sources, and are not formed spontaneously, the water being merely a vehicle for their transportation from place to place. Thus, a water may be grossly polluted by some organic material, but if the specific organisms are absent no disease will result from drinking it.

Formerly, malaria was considered as a water-borne disease and many papers were read at medical meetings on the subject of malaria and swamp waters, but, as we all know now, the mosquito is held responsible.

There is today much speculation as to whether poliomyelitis, or infantile paralysis, is water-borne, but in the absence of a recognized specific organism as a causative agent this still must remain conjectural.

Water-borne Disease Epidemics. A few of the most outstanding water-borne disease epidemics may be mentioned briefly.

In 1887 a cholera epidemic flourished in Messina, Sicily. From September 10 to October 25 there were 5,000 cases with 2,200 deaths. The governmental agencies felt that the water supply was responsible and stopped the use of water from this source. Tank ships were pressed into service to bring in water from the mainland, and as one writer expressed it, "cholera ceased as if by magic." Incidentally, when the Forty-fifth Division of the U. S. Army invaded Sicily in the present war, they took along with them from Africa a five day's water supply of 155,000 gallons. There were three tank ships of 10,000 gallons each, and 125,000 gallons put up in 25,000 five-gallon cans. This was for one division alone!

Another example of a cholera epidemic is that of Hamburg, Germany. From August 1892 to March 1893 there were 17,000 cases, with 8,605 deaths. At that time the population of the city was 640,000. The water supply was taken from the Elbe River and used without purification. Altona, a city so close to Hamburg that the boundary lines were only imaginary, derived its water from the same river, after it had received the sewage from Hamburg, which lay upstream. Altona, however, had a water treatment plant and had practically no cases. Professor Koch, who investigated the epidemic, said, "Cholera in Hamburg went right up to the boundary of Altona and there stopped. In one street which for a long way forms the boundary, there was cholera on the Hamburg side, whereas the Altona side was free from it."

Typhoid-fever water-borne epidemics are much more numerous than cholera. One of the most famous was that of Plymouth, Pa., in 1885, wherein a city of 8,000 population had 1,104 cases with 114 deaths. The epidemic was traced to the water supply, which had been contaminated by throwing the discharges of a typhoid-fever patient on the watershed.

Columbus, Ohio, furnishes another classical example of a water-borne typhoid epidemic. From December 1903 to March 1904 there were 1,646 cases with 166 deaths. The water supply was taken from a river below a point where the sewage from an insane asylum entered and was distributed to the city without treatment. The typhoid death

rate at that time was 139 per 100,000. In 1940 the death rate was 0.3 per 100,000.

Water-borne dysentery epidemics are more numerous but not so severe as typhoid. The one attracting nation-wide publicity was that of Chicago in 1933. About 850 cases of amoebic dysentery with 52 deaths resulted. The city water supply itself was all right, sewage laden cross-connected plumbing being responsible for the epidemic.

These few examples of water-borne epidemics are typical of many more probably not so large but their total cases aggregating many times the aforementioned. That a great many deaths could have been prevented by proper water treatment is self-evident. Shakespeare and Zachary Taylor died from typhoid fever, Louis IX and the German philosopher Hegel from dysentery, and Pasteur's brilliant assistant Thuillier from cholera. What a waste of men and genius has ignorance caused!

Water Purification. The relationship between drinking water and disease having been briefly shown, there remains yet to point out the reduction of deaths due to water treatment. Before doing so it might be well to give a short résumé of the history of water treatment.

Modern water treatment began in 1829, when an English engineer, James Simpson, conceived the idea that by building a sand bed with tile underdrains he could duplicate natural conditions of filtering and obtain a clear water without turbidity such as comes from springs. Accordingly, he constructed a one-acre filter bed at Chelsea, a suburb of London, to filter the muddy water of the Thames River. The results met his expectations, and it was soon noticed that people residing in the district served by this water had better health than those of other districts. In 1855 Parliament passed an act requiring all metropolitan supplies to be filtered. Nothing apparently was known as to what took place in the filtering other than the removal of turbidity. In 1870 chemical analyses were made of the water before and after filtering, but nothing significant was found. By 1885, however, the germ theory had been well established, and it was then discovered that the filters removed bacteria.

Simpson's filters were operated at a rate of about 3,000,000 gallons of water per acre per day. The natural-occurring colloids and silt in the applied water formed a mat on the surface which removed the bacteria. As the mat gradually became thicker with accumulated materials, there came a time when it would not filter properly, and when this occurred the top inch or so of sand was removed by scraping and replaced with new sand. This was a laborious and costly process, and soon machines were developed to remove, wash, and replace the sand.

In 1897 a series of experiments was begun at Louisville, Ky., under the direction of George W. Fuller, and the resulting discoveries revolutionized the technique of water purification. It was found that the mat on the filter could be rapidly produced by means of alum and that the rate of filtration could be increased nearly fifty-fold (125,000,000 gallons per acre per day). Instead of scraping off the sand, a method of "backwashing" was found by applying water to the underdrains and forcing it upwards.

Since then new appliances and other discoveries have been introduced, but the fundamental process remains the same.

In 1908 George A. Johnson introduced the use of chlorine in the form of a hypochlorite as a sterilizing agent to the polluted waters of Bubbly Creek, Chicago. Beginning in about 1913 the use of liquid or gaseous chlorine has gradually replaced hypochlorites, so that at present it is almost universally used in sterilizing public water.

In the past 30 years many improvements have been made in water treatment. Water can be freed from excessive minerals by softening, iron and manganese can be removed by special treatments, and objectionable taste and odor can be eliminated by the use of activated carbon or combinations of chlorine and ammonia. Methods and apparatus are available for removing carbonate, sulphate, or chloride ions, so that a water can be produced that is equal to or even better in quality than most commercially distilled waters.

Reduction in Typhoid Fever by Water Treatment. In the United States typhoid-fever death rates generally furnish the best

criteria in gauging the quality of a public water supply.

In a paper prepared many years ago (1907) by Dr. George Kober, entitled *Conservation of Life and Health by Improved Water Supplies,* a study of 61 water supplies was made, and the results are summarized below. The figures, of course, represent the untreated water.

MEAN TYPHOID-DEATH RATES PER 100,000 POPULATION

4 cities using ground water from large wells	18.1
18 cities using impounded water and conserved rivers or streams	18.5
8 cities using water from small lakes	19.3
7 cities using water from the Great Lakes	32.8
5 cities using both surface and underground water	45.7
19 cities using badly polluted river water	61.1

In 1913 George A. Johnson (who introduced the use of hypochlorite in water treatment) showed that for an average period of about six years prior to filtration the typhoid death rate was 80 per 100,000 and that for the six years following the rate dropped to 21 per 100,000. These figures were based on a study of nine cities. Today a typhoid death rate of 21 per 100,000 would be considered of epidemic proportions.

Studies made in 1940 covering a large number of cities having a total population of 36,000,000 show that the typhoid death rate is 0.48 per 100,000 as against 20.5 in 1910. In the case of Fort Worth, Texas, it has dropped from 27.8 in 1910 to 1.1 in 1940.

There may be some persons who feel that water treatment should not be credited with all this reduction, since numerous other sanitary improvements have been made, and the use of typhoid vaccines has been introduced. Sanitation experts agree, however, that about 70 per cent of all typhoid is traced to drinking water, 20 per cent to milk, and 10 per cent to "carriers." Thus, water treatment should be credited with at least 70 per cent.

Mills-Reincke Phenomenon and Hazen's Theorem. In addition to saving lives as a result of decreased typhoid fever, water purification has further benefits. In 1894, independent of each other, Mills in Massachusetts and Reincke in Germany observed a marked reduction in death rates following the introduction of a treated water supply, which could not be accounted for by typhoid fever alone. This became known as the Mills-Reincke Phenomenon. In 1904 Hazen gave a quantitative expression to the phenomenon, which later became known in public-health work as Hazen's Theorem:

> Where one death from typhoid fever has been avoided by the use of better water, a certain number of deaths, probably two or three, from other causes have been avoided. This seems the clear and logical conclusion from the statistics. It is not easy to explain how the water is connected with the deaths other than those from typhoid fever. It may be that a good water supply, used freely and with confidence, results in a better general tone in the system of the population, and so indirectly to a lower death rate, and that a part of the reduction is represented by diseases having no recognized connection with the quality of the water supply.

All the preceding discussion has been based on the bacterial properties of water supplies. We should remember also that other diseases, not of a bacterial origin, may be traced to a water supply. For instance, there have been numerous cases in which the character of the water was such that it dissolved lead from the plumbing and caused lead poisoning. Water supplies deficient in iodine are considered responsible for much goiter. Excess fluorine in water causes mottled enamel on teeth. There are also waters containing arsenic or copper, excessive amounts of salt, and gypsum or other minerals which may affect one's health.

With the present-day methods of chemical and bacteriological analyses, dangerous waters may be recognized and their use discontinued or prohibited before harm is done.

What is Good Water? This question has been often asked, and to most of us the answer can be simply stated, "Water that does not cause disease is good water." To this, however, can be added a number of other requirements, such as freedom from excessive minerals, taste, and odor. The U. S. Treasury Department has set up certain universally recognized numerical values for the count of bacteria and for the various chemical ions that the water may contain, and if the water meets these requirements, it can safely be called a "good" water.

ELECTRONICS

By JOHN MILLS

ELECTRONICS embraces the science and engineering arts which have to do with freeing electrons from their atomic associations and with controlling them for engineering purposes. Electronic devices are important in all forms of electrical communication, both wire and radio; they are essential in all systems for television and in many military appliances; and they are rapidly finding wide use in industrial application of electrical power and in many manufacturing processes. They are used to convert power from alternating to direct current; to provide high-frequency currents for such widely different operations as tin-plating and the manufacture of plywood; and to control processes like electric welding and proper registration in three-color printing. All these devices are tubes of various shapes that are either highly evacuated—vacuum tubes—or partially evacuated—gas-filled tubes. In these tubes electrons, freed in ways this article will describe, are marshalled into streams by electrical fields. These streams, electrical currents through the tubes, are further controllable in direction and intensity by additional fields, electrical or magnetic.

Electrons can be freed from their atoms by rays of light, more liberally by higher frequency (shorter wavelength) radiation, such as X rays, by those from radioactive substances, and by cosmic rays. They can also be freed by the impacts of other electrons and from metal bodies by the application of heat.

Lightning, an Electronic Phenomenon. A considerable number of free electrons are always moving around among the molecules of the atmosphere, freed from their atoms by the action of sunlight, radioactive substances in the earth's crust, or cosmic rays. Ordinarily these free electrons do not move with the speed required to knock another electron from a near-by gas molecule; but in the lightning season, when high voltages are built up between cloud and earth, they may be accelerated to "ionizing" speeds at which they will knock out a negative electron and leave a damaged atom. The atom which has lost an electron is thereby positively charged. It is now known as an "ion." It moves under the influence of the electrical field between cloud and earth. The newly-freed electron moves in the opposite direction and, if the field is strong enough, may produce more electrons by collisions with other atoms. An enormous stream of electrons is thus quickly produced; that is, there is a large movement of electricity through the atmosphere, a large current of electricity between cloud and earth, called a lightning discharge.

Gas Discharge Tubes. This phenomenon of electrical discharge through gas is most conveniently and safely observed on a smaller scale by using a partially evacuated tube in which metal plates, called electrodes, take the place of the cloud and the earth and are electrically charged by connection to a battery or other source of voltage. It was with tubes of this sort, but with most of the atmosphere pumped out, that scientists in the last years of the nineteenth century proved the existence of the electron and explained the conduction of electricity through gases. It was also with a highly evacuated tube of this sort that X rays were discovered. These rays are produced when fast-moving electrons strike the walls of the tube, and particularly the positive electrode (anode). The electrons by their blows disarrange the electrons in the atoms which they strike, and as these atoms return to their normal arrangement each of them shoots forth a flash of invisible but highly penetrating X rays. In the modern X-ray tube the vacuum is so high that electrons only very rarely collide with atoms and produce electrons by collision. In these tubes the electrons are supplied by heating the negative electrode (cathode).

Tubes similar to the gas-discharge tubes used in the discovery of electrons, that is, partially-evacuated tubes in which there is a miniature lightning discharge, are used today as neon lamps and as sources of fluo-

rescent lighting. Their production of light is essentially the same as in the lightning flash. When, during the discharge, an electron meets a positively charged ion, the two oppositely charged particles may combine to form a normal atom. Then the energy of their collision is radiated as a speck of light —as a "photon." Not all collisions of electrons with atoms occur at ionizing speeds, capable of knocking out electrons. They may result merely in some disarrangement of the electrons of the atom. Almost instantly, however, the atom rearranges itself into its normal condition, and as it does a flash is radiated. In lamps most of the light is due to the action of such "excited" atoms.

Photons and Photoelectric Effects. Photons are little bundles of energy, little "bullets" of light. They are produced when the electrons of an atom rearrange themselves, whether in the mild action of "excited" atoms, or in the more severe recombination of electron and ion, or in the many times more powerful action of the rearrangement of the innermost electrons of heavy atoms which give rise to X rays. The shorter the wavelength of the emitted light the greater is the energy in the photon. Photons of ultraviolet light and particularly of X rays are capable of ionizing atoms upon which they strike. Even the less powerful photons of visible light can knock electrons out of metal bodies, because in such bodies there are always many electrons which are already free from their original atoms and are wandering loose in the relatively vast spaces between the atoms. This phenomenon of light freeing electrons from metals was discovered before the electron, but not explained until afterwards. It is known as the "photoelectric effect," and it is the basis for the liberation of electrons in the vacuum tubes used in television and other tubes called photoelectric tubes—or called phototubes, if not highly evacuated—which act as relays to turn on or off electric currents in response to light.

Electrons from Heated Metal. A third method of freeing electrons, and the one most commonly used in electronic devices, is to liberate them by heating metal bodies. In metals, as was implied above, the outermost electrons of atoms are not as closely held as in nonmetallic atoms. In a metal body, therefore, there are always many electrons free from their atoms and engaging in a haphazard motion in the relatively enormous open spaces between near-by atoms. These electrons explain the conduction of electricity in metals and also the higher conductivity of heat, which is characteristic of metals. A current of electricity through a metal body is merely a stream of these freed electrons; in a wire they are forced to travel from the end connected to the negative terminal of a power source, e.g., battery, to the positive terminal. In so doing, however, they must dodge and jostle their way past the atoms. These they set into more violent motion, producing a greater molecular agitation, that is, a greater amount of heat in the wire. Larger electric current means more electrons per second passing a cross section of the wire, and also more heating.

The electrons which take part in electrical conduction through metals are ordinarily kept within the bounds of the wire by the attraction of all the near-by atoms. However, if they are moving very fast, as they are when the wire is red hot, some of them may be able to shoot beyond the attraction of the wire as a whole and escape into the surrounding space as free electrons. At white heat a few hundred billion electrons will escape each second from each square centimeter of the surface. These electrons are sometimes called "thermions."

Electrons are produced equally well from a metal whether it is heated by the passage of a current or by heat externally applied. The high conductivity for heat in the case of metals is explained by the presence of the wandering electrons. Heat applied at one spot of a body sets the electrons at that point (and also the atoms) into more violent motions. The electrons quickly transfer that energy to neighboring electrons (and to their near-by atoms); there is heat conduction through the body. If the heat is sufficient the electrons may move so fast, on the average, that some will break away, and then there is a "thermionic emission."

Vacuum and Gas-filled Tubes. In electron tubes the free electrons are controlled by

applying voltages to the electrodes. In all cases there must be two electrodes. A stream of electrons will then flow through the tube from the cathode (negative terminal) to the anode (positive terminal). Tubes are divided into classes depending upon whether or not the electrons are derived from a heated cathode; and also as to whether or not they are vacuum tubes (that is, tubes with so little gas that collisions rarely occur) or partially-evacuated (that is, gas-filled tubes). In all gas-filled tubes the main supply of electrons for the current through the tubes is ionizing collisions of free electrons and gas molecules. The relatively few free electrons which initiate the discharge and start the sequence of ionizations may, however, be derived from a hot cathode. In the gas-filled phototubes the electrons which initiate the discharge are photoelectrically emitted from an unheated cathode.

One simple rule determines the engineering choice between vacuum and gas-filled tubes. If one wants an exact correspondence between cause and effect—if, in other words, as in communication, one wants a current which exactly conforms to some cause, for example, a spoken word or a television signal—one uses a vacuum tube because the electron stream can be kept precisely proportional to the signal. If, on the other hand, one wants merely to produce a rapid and large passage of current when the discharge is to be triggered off, then one uses a gas-filled tube and lets the exciting cause initiate a small lightning discharge through the tube.

Tubes with Grids. The electron stream from cathode (filament) to anode (plate) can be controlled by interposing grids between filament and plate. The introduction of a grid for such control of the current was the epoch-making invention of Lee de Forest in 1906. A grid is a gridiron structure of wires. To electrons at some distance it acts like a continuous surface and attracts these negative particles or repels them, depending upon whether it is positively or negatively charged. To electrons a grid is a deceitful structure because it speeds electrons toward itself, but they get going so fast that their paths are not diverted to its individual wires, and most of them pass through the open spaces of the grid. The grid is strategically interposed between the filament (cathode) and the plate (anode), but nearer the filament, so that it has a disproportionate influence on the electrons. A small voltage applied between the filament and the grid is equivalent in its effect upon the stream of electrons to a voltage many times larger applied between the filament and the plate.

When this arrangement is used in communication circuits, the signal is applied between the filament and the grid; the "load," e.g., a loudspeaker, is connected, usually through a transformer, in series with the battery in the external path from the filament to the plate. The result is a current through the load similar to that impressed on the grid, but much larger; that is, it is amplified. Amplification is the most important characteristic operation of the three-electrode tube (triode). It can, however, perform two other essential operations of electrical communication; namely, first modulation or demodulation, and second, the generation of alternating currents. Which operation it does perform depends upon the magnitude and character of the voltages applied to its electrodes and upon the other circuit elements—capacitances and inductances—connected to them. When the tube is to be used in communication circuits, the usual practice is to introduce two extra grids, making a five-electrode tube (pentode). Then, properly designed and operated, it has wider range of action and can handle greater signal energy without distortion.

Diodes. Tubes with only two electrodes (diodes), however, have many uses. That is the structure of X-ray tubes, of fluorescent lamps, and of rectifiers for the conversion of alternating current into direct for charging storage batteries, processes of electro-chemistry, supplying current to home radio sets, and to dust and smoke percipitators. Except for the X-ray tubes which, like those used in communication, are vacuum tubes, the rest of the diodes just mentioned are gas-filled. The functions they perform are primarily those of electrical power. Photoelectric tubes also and the gas-filled phototubes are diodes.

Power Tubes. The other tubes used for

the control of electrical power are usually triodes, but a few types are tetrodes. They are all gas-filled. Their purpose is to release a sudden surge of current, through an external circuit connected between cathode and anode, when triggered off by applying a small voltage to the grid. The energy comes from the power source connected between cathode and anode, but it is controlled so far as starting is concerned by the electrical condition of the grid. In general, these tubes get the electrons which are to initiate the discharge current from a hot cathode. In one scheme of operation the voltage applied to the anode is sufficient to accelerate electrons to ionizing speed and so start a miniature lightning discharge. Until action is desired, therefore, the grid is maintained sufficiently negative to repel the electrons back toward the cathode and prevent them from ionizing the gas. Because of the strategic position of the grid this is easily accomplished by applying to the grid a relatively small negative voltage. In the other scheme the anode voltage is not sufficient to start ionizing collisions; and to start discharge it is aided by a small positive voltage applied to the grid.

These power tubes can handle currents of hundreds and thousands of amperes at high voltages. In the smaller tubes the hot cathode is usually a filament, but for those of higher power it is usually a pool of mercury. Once the discharge is started the mercury acts like a hot cathode, for its surface will be heated by the blows of the positive ions of the gas which are attracted to it. Such tubes are usually started by applying a small voltage to a third electrode—not grid-shaped but equivalent in action, so far as starting is concerned, to the positive grid described in the preceding paragraph. This electrode, sometimes called an "igniter," makes a rough contact with the surface of the mercury and sets up a small discharge current to itself, thus heating the mercury at the contact point and providing a source of electrons. The electrons that are freed stream toward the anode, ionizing as they go; and the positive ions moving in the opposite direction by their impacts on the mercury surface maintain its electron emission. The discharge current continues only as long as the voltage is applied to the anode. If this is alternating, the discharge is intermittent.

Cathode Ray and Television Tubes. If in a diode, in which an electron stream passes from a hot cathode to a positively charged anode, there is a hole in the center of the anode, a stream of electrons will pass through to the end of the tube. This arrangement is an electron gun. The stream of bullets (electrons) leaving its muzzle continues in a straight line, except as deflected by an electric or magnetic field. If the end of the tube is coated with a fluorescent substance, such as zinc sulphide, their blows cause a spot of light. As the path is bent by the impressed fields the spot traces a continuous pattern.

This cathode-ray tube can disclose the instantaneous variations of a complex alternating current. The unknown current supplies a field to move the beam up or down while an auxiliary direct current steadily sweeps it sidewise. The spot draws an accurate picture of the current's wave form. The spot's vertical displacement measures the intensity at instants recorded by its horizontal position.

The same principle is employed in tubes for television receivers. The beam is swept from left to right, by one field, then almost instantaneously returned for the next trip, which it makes, however, at a slightly lower level to which it has been shifted by the vertical field. The beam makes 441 sweeps in one thirtieth of a second, and then returns to its starting point. In thirty turns a second, therefore, it covers successively every point in a rectangular picture frame. The intensity of the light spot in the meantime is instantaneously varied in accordance with the intensity of the light in the corresponding point of the distant scene, a result that is accomplished by transmitting to the television tube a current, derived from a photoelectric tube, which corresponds at each instant to the light in the scenic detail then under observation. This current is supplied to a grid to increase or decrease the electron stream that issues from the gun's muzzle.

The Electron Microscope. Electron microscopes use streams from an electron gun in much the same way as an optical microscope uses beams of light from a substage condenser. Beams of high-speed electrons can be refracted to a focus by electromagnetic lenses, which are coils carrying currents and

so establishing a magnetic field through which the beam is caused to pass lengthwise. Since glass and other materials are only very slightly penetrable by electrons, the object under observation must be very thin and mounted on a slide of only the merest film of celluloid. The image is formed on a photographic film in a manner similar to that of the optical instrument. Because a high-speed electron has, in effect, a wave length shorter even than ultraviolet light, the electron microscope permits the observation of greater detail than the optical microscope. Whereas the optical microscope may give a magnification of 2,000 diameters, the electron microscope, still capable of improvement, has a magnification of 100,000 diameters.

Uses of Electron Tubes. Electron tubes—exclusive of cathode ray tubes and electron microscopes—find their greatest use as circuit elements, just as do switches, relays, generators, and transformers. They are adaptable to three main purposes: (a) as relays, that is, as switches or controllers of current; (b) as generators, that is, converters of power from one form to another, as from direct to high-frequency alternating current; and (c) as modulators (or demodulators) to scramble (or unscramble) currents, *e.g.*, in electrical communication, by telephone and the radio. Unlike ordinary switches and electromagnetic relays, the electron tube (triode or pentode) has the unique characteristic of amplification. A small effect imposed upon the grid causes a correspondingly large effect in the output current, the energy for which is supplied by the power source of the tube. In communication circuits when vacuum tubes are properly used, a small signal current can be amplified very many times without distortion. In power circuits such exact correspondence between cause and effect is not necessary and a large surge of current can be triggered off under the grid's control. In photoelectric tubes and in phototubes, which are their gas-filled counterparts, the output current is under the control of the light to which the photo-emissive cathode is exposed.

The use of electron tubes as generators derives from their ability to amplify. For this purpose they are arranged so that a portion of the output current is fed back to the grid. This input to the grid is then amplified and results in a still larger output current. Operating in this hoop-up, the tube will produce an alternating current of frequency determined by the capacitance and inductance in the circuit connecting output to input, that is, connecting the plate to the grid. The tube then serves as a generator of high frequency current, that is, as a converter of direct current into alternating current. This operation is essential to many types of electrical communication, especially the radio. It is also basic to all industrial uses of high frequency currents for heating, such as induction heating, dielectric heating, and high frequency therapy.

The operations of an electron tube as modulator or demodulator are essential to all forms of electrical communication except the simplest. In general, the tube is used when currents are to be stepped up or down in frequency. It was the operation of demodulation, so successfully performed by the de Forest audion in detecting radio signals, that attracted powerful attention to his device. (It was the ability of that structure under proper conditions to act as an amplifier that gave it its real start in the communication arts and led to applications in other arts. The three electrode vacuum tubes as an amplifier [telephone repeater] made possible long distance wire communication.) The ability of the tube to modulate a current, i.e., to vary it in accordance with the variations of another current, provided the basis for radio telephony and, in general, for multichannel communication whether through space or over wires. Each message is "carried" by a modulated current of a distinctive frequency, or by radio waves established by the current. The several carrier currents are produced by electron tubes acting as generators. At a common receiving station the several messages can be distinguished by the frequencies of their carrier currents; and can be separated and routed to individual equipments for demodulation. In effect, in this process an audio-frequency signal is first raised to a radio frequency and returned to its original frequency—and all without loss of significance.

IT MIGHT HAVE BEEN BANKSIA

By EMILY EVELETH SNYDER

OUR letters from the continent down under might begin *Somewhere in Banksia* instead of *Somewhere in Australia,* if Linnaeus had had his way. Hundreds of names that this Swedish botanist gave to plants are in use today, but for some reason the name he suggested for a continent was not favored.

The man Linnaeus wished to honor was Sir Joseph Banks (1743–1820). Banks never led an expedition to Australia. He was not primarily interested in acquiring territory. He did not even hold an army or navy rank when he sailed with Captain Cook on his first voyage around the world. As a matter of fact, Banks furnished the equipment and supplies for himself, for Dr. Solander who was his secretary and a former pupil of Linnaeus, and for his four servants. Banks' interest was in science, particularly in the collection and study of plants.

Banks was 25 years old in 1768, the year Cook sailed in the *Endeavor*. He had already made collections in far-off places. Two years before this he had sailed to Newfoundland and Labrador with Lieutenant Phipps, later Lord Mulgrave, who was one of a party sent there to investigate the fisheries. This trip kindled in Banks a desire for wider travel, in spite of the fact that he had found the mosquitoes almost unbearable, had been ill with fever, and had lost most of his precious seed collection and the potted plants he was taking to England. The storm that caused his losses made it necessary for the boat to land at Lisbon. Banks never published a report of this excursion to America, but at Lisbon he was given something that became the talk of his fellow naturalists. This was a present of two balls of the "new Elastick Substance." In a history of the Royal Society this is said to be the first specimen of rubber seen in England.

After the American trip, his friends suggested that Banks make a tour of Europe, as befitted a young and wealthy gentleman, but when the opportunity to sail with Cook presented itself, Banks referring to the European trip said, "Every blockhead does that: my Grand Tour shall be one round the whole globe."

The circumstances that made it possible for Banks to go with Cook were in part due to his friendship with Lord Sandwich, Lord of the Admiralty, whom he had met while on a fishing trip. Fishing, collecting natural history materials, and studying agriculture on the family estate occupied most of Banks' time after he finished the regular classical education of the times with a degree from Oxford.

The entire direction of Banks' very active life seems to have been set by an apparently minor incident. One day, while a student at Eton, he went swimming with some boys and had such a good time in the water that all the others left before he was dressed. Wandering back alone, he was so impressed by the flowers along the way that he decided to study botany. Since the subject was not taught at Eton, he began to go places where old women were collecting medicinal herbs to sell to pharmacists. He asked them all sorts of questions and paid them for any information that was of value to him. His method of self-education became more speedy after he returned from a vacation at home with an illustrated copy of an *Herbal* he had found in his mother's room. He continued his study of botany in college even when he himself had to make arrangements for a lecturer in the subject. Joseph's father, a Member of Parliament, would probably not have selected natural history as the life work of his son, but he died before his son finished Oxford and left the young man a fortune. Beginning with his expenditures for the Cook expedition, throughout his life Banks spent large sums of money on projects to increase scientific knowledge.

The main purpose of Cook's first voyage to the Pacific was to take astronomers there so they could get a good view of the transit of Venus across the disc of the sun. The first recorded transit occurred in 1639. Two

others were predicted for 1761 and 1769 by Halley, the discoverer of the comet that perpetuates his name. A voyage to the Pacific in those days now seems like a tremendous undertaking for such observations, but the data were needed for calculations being made on the distance between the sun and the earth. The observations made in 1761 left much to be desired, so at the urging of the Royal Society Cook was backed by the government and left England again in 1768.

After a trip high-lighted by many adventures along the coast of South America and among the islands in the Pacific, the astronomical equipment was set up on an island near Tahiti. The third of June, 1769, was perfect for the observations which were made under the direction of Mr. Green, the astronomer of the expedition.

Banks, by this time, had won great popularity among the islanders, so much that he was constantly called upon to arbitrate in cases of thefts by natives and in troubles between them and the crew members. On June 3d, a native king and his sister arrived to pay Banks a visit. Banks took his royal guests to the observatory and showed them the planet as it was crossing the sun's disc. He explained that it was to witness this event that he and his companions had made the long trip from England.

With the prime purpose of the expedition out of the way, Cook was free to explore. After surveying the coast of what is now New Zealand, he sailed westward. On the 29th of April, 1770, the expedition landed at a place Banks christened Botany Bay, because of the enormous number of strange plants he saw there.

During the next five months Banks and Solander, with their assistants, spent as much time as possible on shore collecting and preparing specimens of plants, of insects, and of fish and other animals. When Banks returned to England in 1771, this collection amazed his fellow naturalists, while the man on the street was much impressed by the descriptions of kangaroos and of bats with a wing spread of a yard. Banks was also able to make reports on the customs of many of the native tribes he had seen.

Almost as soon as the results of Cook's voyage were made known, preparations were begun for his return to the Pacific. Banks made plans to accompany him and bought a large amount of equipment. However, difficulties arose. Records are in disagreement as to the nature of the trouble, but Banks did not sail with Cook in 1772, although the friendship of the men was continued after Cook's return.

Since he was outfitted for a voyage, Banks chartered a ship and visited Iceland. Among his guests were Dr. Solander and Dr. James Lind. The latter, incidentally, was one of the first to advocate the use of citrus fruits to prevent scurvy on ships. Although the travelers brought back many interesting specimens of plant and animal life, and some Icelandic manuscripts they had purchased, the real benefactors of this trip were the inhabitants of Iceland. In 1808 England and Denmark were at war, and the British navy made it impossible for any ships to reach Iceland. The people there were reduced to such want that they visited the beaches after each receding tide to gather seaweed for food. The condition of the Icelanders was brought to the attention of Banks. Through his influence, as an honorary member of the Board of Trade, licenses were issued giving safe passage to some provision ships.

Banks never made another extended trip outside of England, but he became one of the most widely known men of his time. Beginning in 1778, Banks served for forty-one years as President of the Royal Society. This alone would have been enough to make him famous among scientists. But it was his interest in horticulture, in general, and in the Royal Gardens at Kew, in particular, that made his name familiar in the most isolated parts of the world.

Immediately after Banks' return from the Pacific, he and Solander were given an audience by King George III. From this time Banks became an adviser to the king on agricultural and horticultural matters. In this capacity he rendered the English sheep raisers great service. There is a letter from Banks to the king, dated August 10, 1787, in which he states that he has ordered two rams and two ewes of the finest Spanish

breed for the king's flock. How important merino sheep became may be judged from the prices they brought. In 1804 a ram from the king's flock sold for 42 guineas.

In 1808 nearly two thousand sheep arrived in England as a gift for the king from the Spanish government. Banks was directed to distribute these. He saw that they went to owners of flocks who could make the best use of them "to improve their British wools by the aid of this valuable cross."

Being chief adviser in matters pertaining to the Royal Gardens at Kew seems to have increased Banks' tremendous enthusiasm for plant collecting. Banks gave men in all parts of the world directions about collecting and shipping plants. He backed botanical expeditions and urged physicians and explorers to send him information about useful plants found in new colonies. It is estimated that 7,000 new plants were introduced in Kew Gardens during the reign of George III. Banks was directly or indirectly responsible for the arrival of most of them.

His own travels and his contacts with collectors all over the globe made Banks an exceptionally well-informed man. It was Banks who was asked to draw up instructions for David Nelson, the gardener who was in charge of the bread-fruit trees that were to be taken by Bligh from the Pacific Islands to the West Indies. It took five months to get the thousand bread-fruit and other trees satisfactorily stored on the *Bounty*. Undoubtedly the easy life the crew led during this time caused the unrest that became mutiny after they were at sea. Banks was enraged at the news of the mutiny. Later, when the opportunity came, he backed Bligh as governor of Australia. Bread-fruit trees were finally taken to Jamaica by another expedition encouraged by Banks.

Banks may have been the originator of the plan to colonize Australia. Anyway, he was called before a committee of the House of Commons when preliminary discussions were going on. His enthusiasm for Botany Bay was so great that it was designated as the port of disembarkation for the first fleet load of colonists. On his arrival there, Captain Phillip found it unsuitable and moved up the coast to the present site of Sidney.

At this time confusion was great about the land down under. The name New Holland was applied to the western part of the continent, and Cook had called the eastern part New South Wales. Doubt even existed whether these two regions were parts of the same body of land. Largely through the influence of Banks, Captain Flinders was sent out, near the beginning of the 19th century, to complete the survey of the coast lines in the region of New South Wales. The botanist on this trip was Robert Brown.

In 1777 Banks had taken a large house in Soho Square in London. Visitors described it as a veritable museum. Banks was very generous in allowing scholars to examine his collections and to use his books. One of the young men who frequently went there was Robert Brown. After Banks' attention was called to him, he recommended the young botanist for the trip. Brown brought back so many specimens from down under that the cartage charge from Liverpool to London was fifty-three pounds. He had nearly three thousand species of plants from Australia.

Flinders succeeded in circumnavigating the continent. He then pointed out that the names in use were applied to the same land mass and suggested that both be given up in favor of the name Australia. This name had been loosely applied to lands lying between South America and Africa. Banks, among others, objected to this name. However, in 1817 the Governor requested that Australia be adopted in all dispatches. The next governor, in a subtle way, indicated he was ready to make the name more permanent. He named his daughter Eleanor Australia Brisbane. And so the continent that received so much attention from Sir Joseph Banks became Australia instead of Banksia.

SCIENCE ON THE MARCH

SCIENCE AND TUBERCULOSIS

Now is the time for research on tuberculosis. In this country improved methods of detection and government support for mass surveys are disclosing hundreds of thousands of unsuspected cases. Opportunity is now created for a superb national investment in devising methods to encircle permanently the spread of infection from these known sources.

While estimates differ sharply, there are from one to two million potentially infectious people in this country, and at least 25 million among the 500,000,000 people of Europe. Tremendous problems exist also in South America and the Orient. Our country, the richest in the world, has now approximately one hundred thousand beds available for controlled segregation. It is a choice of interest, that between more hospitals and improvement of method.

One reason for emphasis on research and preventive work is that our weapons for treatment of tuberculosis are more obsolete than those against any other great infection. We have quinine and atabrine (as well as DDT) for malaria, sulfadiazine for streptococcus infections, penicillin for pneumococcus and staphylococcus, but nothing at all comparable for tuberculosis. The unchecked disease, also, neither heals nor kills in many instances, but rather drags on for years. Care of each victim therefore, cured or uncured, requires many months, and often thousands of dollars. In a field where radical improvement of method is most desperately needed, funds available to fight tuberculosis too often lack courageous research direction, and become absorbed in palliative work. Meanwhile the great advances in preventing and handling other infectious diseases provide many too long neglected leads for attack.

Tuberculosis bacteria, like other disease agents spread by air, food, or water, are most easily and cheaply exterminated outside of the body, where we have them in the open. This will remain true even if a new "penicillin" or sulfa drug is discovered for tuberculosis. It will always be easier to pasteurize milk than to cure spinal tuberculosis. In fact, it is easier to kill the tuberculous cow, and, if necessary, cook it thoroughly for meat, than it is to cure intestinal tuberculosis. In this country, 1 out of 200 cows is still tuberculous, and in Europe about 35 out of 100. Pasteurized milk is needed still.

But pasteurized air is needed more. Ninety-five per cent of human tuberculosis starts as a lung disease, and the fatal dose of bacilli by inhalation is probably less than one millionth part of that by mouth. True, it is more costly to pasteurize the air of public buildings than it is to pasteurize milk. The best method, or combination of methods, to purify air in each situation remains to be found by determined investigation. Engineering developments should swiftly follow. The air-conditioning manufacturers, who have worked on heating, cooling, humidity control, and even pollen removal, are just beginning to consider a new and incalculably important aspect of their problem. Contaminated air is the main source of 20 great infections, such as tuberculosis, the common cold, pneumonia, rheumatic fever, septic sore throat, and resulting heart trouble and arthritis. The public, which approves of research and preventive medicine, approves of them feebly; the medical and nursing professions, which know better, acquiesce: The motto in dealing with these infections is still "Billions for tribute; five dollars for defense."

The heat we use to warm our public buildings in winter is enough to pasteurize the agents of upper respiratory infections. The ultraviolet light which cleanses outdoor air can be made to purify indoor air. Moreover, bacterial and virus dust can be partially trapped by filters, more thoroughly precipitated electrically, or chemically sterilized. In provisional tests the author has seen that harmless, imperceptible gases, the glycols,*

* Developed by a distinguished group of scientists, working with the leadership of O. H. Robertson. These gases are the only agents known which can be made to act throughout a space continuously, night or day.

exterminate air-borne tubercle bacilli, under conditions yet to be defined. Development of this application, among others, is most urgently needed.

The concentrated effluvia of coughing, crowded, migrating, starving millions of Europe is at work. Millions of homes there have been destroyed or damaged, millions of evacuated families jammed into insufficient quarters. Yet more numbers of infected prisoners are tramping homeward. Whole armies will soon disband. Even in this country many thousands of infected veterans will return to crowded, unsafely ventilated hospitals, asylums, and sanatoria. We must segregate them to guard the health of the public and thousands of exposed attendants.

If indeed we must continue to breathe infectious bacteria and viruses, then we should "practice" our tissues on weakened or killed vaccines. "B.C.G." is a "weak sister" of a tubercle bacillus inoculated alive as a vaccine. Many killed vaccines have been proposed, including both extracts and whole bacilli, such as the "asphyxiated vaccine" of the author. In general, the aim has been to kill firmly but gently, retaining immunizing power. A given weight of killed vaccine, unless an essential principle is extracted, will always be less effective than an equal weight of live vaccine, which multiplies for a time, and therefore stimulates the tissues more widely. The natural infecting doses to be protected against vary, but are in general divided doses, not all inhaled at once, and evidently less in amount than enough to be fatal at any one time. It is therefore doubtful what statistical differences might be found between living and killed tuberculosis vaccines, since a factor of natural reinforcement almost invariably exists.

The potential value of killed vaccines is not seen, even by many experts. Killed vaccines often fail in hypersusceptible animals, such as the guinea pig and monkey, and produce no striking effect either in highly resistant animals, such as the carnivores. The best test animals are those of intermediate grades of resistance to various types of tubercle bacilli, such as rabbits and swine. Immunization against infection may be compared to diking against a flood. On a very low bank the row of sandbags is useless; on a very high bank it is needless; on a bank of medium height it may just prevent misfortune. Different strains of people also vary in resistance, but far less than varying species. Only long term comparative tests of vaccines are of any scientific value. Against tuberculosis, the author recommends trial of vaccination in a limited group, the tuberculin-negative individuals necessarily exposed. This might include some children in Europe and some nurses in this country, also some war prisoners who are often crowded in a heterogeneous fashion, even in this country. Whole bacillus vaccines absorb slowly, but it is strange that a profession which has the courage to perform lobectomy operations hesitates to study killed vaccines.

Because of the slow growth of the tubercle bacillus, research thereon requires a coincidence of long experience, sustained interest, adequate support, good ideas and often unusually large space for animals—to circumvent this slow growth by many experiments abreast. Now is the time, Administrators, Philanthropists, Scientists and Public Health Workers! Tuberculosis now threatens to take back the dearly bought ground it previously lost to the onward march of civilization. Men of all nations, too long constrained to unwelcome tasks of war, should soon combine against this common foe.—TRUMAN SQUIRE POTTER, Department of Pathology, Dartmouth Medical School, Hanover, New Hampshire.

GROWTH REGULATORS IN PLANTS

SOME of the aspects of plant growth most likely to be taken for granted are actually the most difficult to explain. Why, for example, do leaves develop when they do, their blades expand just so much, and then stop? Why does one stem on a plant elongate more than another on the same plant over the same period of time? Why do flowers appear on a plant when they do, or, for that matter, why do they appear at all? Why do new roots develop much more readily on a plant at certain times than at others? And, equally important, how is the growth or development of one organ of a plant co-

ordinated and correlated with that of others so that one organ does not develop disproportionately to, or out of step with, others?

The development of any given organ on a plant is more or less influenced by the direct effects of environmental factors, but is also affected by its other organs. Several physiological mechanisms have been recognized by which one organ of a plant may influence the development or reactions of others. Such effects may result from the influence of one kind of organ, such as developing fruits, upon the distribution of water, necessary mineral ions, or foods to other organs, such as growing stem tips. Gradually, however, as a result of recent and continuing investigations there has been unfolding the pattern of another, and perhaps more fundamental, type of mechanism of the internal controls exerted by one plant organ upon the development or behavior of another. Among the innumerable synthetic products of plants are certain physiologically highly active compounds which exert regulatory effects on developmental processes in plants. The effects induced by these compounds are often seemingly out of all proportion to their quantity: profound influences on plant growth or reactions are frequently caused by almost inconceivably low concentrations of these substances. Most frequently a naturally occurring plant growth regulating substance is synthesized in one organ or part of the plant from which it is transported to some other part, where it exerts its influence on the growth of the receptor organ or tissue. The behavior of these substances is thus like that of hormones in the higher animals, and they are often referred to as plant hormones.

The substance *thiamin* (vitamin B_1), well known as a necessary constituent of the diet of humans and animals, plays the role of a hormone in plants. Some years ago it was discovered that detached roots will grow indefinitely in a sterile liquid medium containing only dissolved sugar and certain mineral salts, provided only that a small amount of yeast extract be also added. Later it was found that thiamin was the one ingredient of the yeast extract which appears to be necessary for the growth of the roots of all kinds of plants. In intact plants thiamin is synthesized in the leaves and translocated down into the roots. Roots are therefore dependent upon the leaves for the supply of the required root growth substance thiamin. If the downward movement of thiamin to the roots is interrupted in any way, growth of the roots is retarded or stopped.

The *auxins* have been the most exhaustively studied of all the plant hormones. These substances, at least some of which have been isolated from plants and identified chemically, play roles in a number of different growth phenomena. Their most fundamental effect is on the elongation of plant cells, such as those involved in the growth in length of stems and other plant organs. In the absence of auxins, elongation of cells fails to occur and, within limits, cell elongation is proportional to auxin concentration. The auxins are not synthesized, however, in the zones of cell elongation, but in the still younger regions closer to the tip of the elongating organ in which cell divisions are occurring. Hence auxins must be translocated from the site of their synthesis to the cells which are elongating. Cutting off the tip of a growing stem stops, or at least greatly checks, its further elongation because the supply of auxins to the zone of cell elongation has been curtailed.

Another role of the auxins is in the development of roots, an effect that is most clearly illustrated in the rooting of cuttings. If the basal ends of stem cuttings of many kinds of plants are stuck into moist sand, roots commonly develop on the underground parts of the cuttings. The roots that develop on a cutting are usually more vigorous, however, if it bears leaves or healthy buds than if it does not. The explanation of this fact seems to be that certain hormones made in the leaves or buds are necessary for the formation of roots on the basal portion of a cutting. Such hormones move down the stem and accumulate just above the basal end of the cutting in greater quantities when leaves and buds are present in relative abundance than when they are not. Thiamin, as already mentioned, is one of the plant hormones required in the development of roots. Auxins also play a role in root for-

mation, and it is possible that other growth regulators having their origin in the leaves, buds, or stems are also necessary for the development of roots. Within limits, at least, the greater the supply of these growth regulators to the buried part of the cutting, the more vigorous the development of roots from it.

An important feature of the growth of plants is the expansion of the small blades of very young leaves into the larger blades of older leaves. The occurrence of this process requires the presence of specific growth regulators. If young leaves are floated in the dark on solutions containing sugar, auxins, and other known growth regulators, they fail to expand. But if a trace of the compound *adenine* is also introduced into the solution, expansion of the blades proceeds. This substance thus acts as a specific growth regulator of leaf expansion. In intact plants the hormone which exerts a controlling effect on leaf expansion is apparently made in mature leaves and translocated to younger, still expanding leaves. Older leaves may thus exert a regulatory effect on the development of younger leaves.

The initiation of flowers by plants is also subject to internal control. Flowers develop only if specific substances are supplied from the leaves to the growing stem tips of the plants. In default of a supply of such substances the stem tips may continue to grow but develop only vegetative parts—stems and leaves. The name "florigen" has been given to this substance or group of substances. Synthesis of florigen in the leaves is profoundly influenced by certain environmental conditions, especially the length of the daily period of illumination and the temperature. For a given kind of plant florigen is synthesized under some environmental conditions but not under others. For experimental purposes many plants can be brought into flower or kept in the vegetative condition at will by controlling the environmental conditions to which they are subjected and thus, indirectly, the synthesis of florigen.

Roots as well as leaves are the centers of the synthesis of certain growth-regulating substances. One of these is the hormone called *caulocaline* which is necessary for the normal elongation of stems. Stem elongation apparently takes place only in a zone where upward moving molecules of caulocaline from the roots and downward moving auxin molecules from the stem tips meet. Under some environmental conditions the caulocaline output of the root system may be curtailed. In some kinds of plants caulocaline synthesis is reduced if the roots are inefficiently aerated; this in turn may result in a stunting of top growth.

In addition to the naturally occurring growth-regulators, a number of organic compounds not positively known to be present in plants have been discovered to have effects on plants similar to those of some of the autogenous plant hormones. Many, although not all, of these "synthetic hormones" resemble the auxins in their effects on plants and are often so classified. Among the better-known compounds in this group are indole butyric acid, alpha naphthalene acetic acid, and naphthoxyacetic acid.

There are several important uses of growth regulators in the practical control of plant growth and behavior. Among other effects of the auxins is that of retarding leaf-fall. Leaves properly treated with an auxin remain attached to the stems longer than similar leaves not so treated. Soon after its discovery, this principle was applied to problems of economic consequence. Spraying of apples with a suitable auxin solution at the proper time to prevent premature dropping of the fruits has recently become an important horticultural practice. The prolonged retention of apples on the trees permits picking them before they fall to the ground and deteriorate in quality. This application, the outgrowth of a discovery of sometimes disparaged "pure science," has probably already more than repaid society for all of the funds ever spent on hormone research in plants.

Another widely used practical application of knowledge of plant hormones is the pre-treatment of cuttings with auxins. Roots form more abundantly and more quickly on cuttings of many kinds of plants if they are given such a pre-treatment than if they are not. Such artificially applied auxins pre-

sumably supplement and augment the effect of the auxins naturally present in the cutting. Rooting of some kinds of cuttings is also improved by a pre-treatment with thiamin in addition to the auxin treatment.

Control of certain aspects of the development of fruits can also be exercised by the use of growth-regulating substances. Usually fruits develop on plants only after pollination has taken place. If, however, pollination is prevented or fails to occur naturally and a suitable hormone is introduced into the pistils of the flowers, development of the fruits will take place much as if normal pollination had occurred. Such fruits are seedless—even seedless watermelons have been produced by this technique. During the winter season the pollen of tomatoes being grown under glass has a low viability, and one of the practical applications which have been made of this discovery has been to supplement the normal pollination process with hormone treatment of the flowers of such plants and thus insure a much greater yield of tomatoes. Such fruits may be fully equal in size and quality to those developing after normal pollination.

The examples given are only three of the more widely used applications of the newer knowledge of plant growth-regulating substances. There are good reasons for believing that we stand only at the threshold of developments in this field of knowledge. Hitherto man's control of plant growth has depended almost entirely upon the selection or breeding of desirable varieties of plants and the control or at least selection of the environmental conditions under which plants are grown. With the discovery of the effects of plant growth regulators, some of natural occurrence, others of synthetic origin, new tools have been placed in his hands whereby additional controls can be exerted on at least some kinds of plant growth and behavior. More and more in years to come it will be possible for the plant scientist and even the practical grower of plants to become, within limits, a sculptor of life itself, molding plants more or less to suit his own needs or desires.—B. S. MEYER, Department of Botany, The Ohio State University, Columbus, Ohio.

THE PROTECTION OF TEXTILES AGAINST BIOLOGICAL DECAY[1]

COTTON, linen, hemp, jute, paper, and cardboard are all forms of cellulose, and are all subject to decay by mould fungi and bacteria. Even in peacetime the economic losses resulting from this type of destruction alone are quite spectacular. Fishing nets, awnings, tentage, tarpaulins, sacks, ropes, and so on are all liable to attack by a variety of organisms which are not only diverse in character but also widespread over the whole globe. The destructive activities of these microbes may occur in materials in storage, in transport, and in use, and practically the only thing that will "stop the rot" is absence of moisture. Now, the margin between the normal moisture-content of some fibers and fabrics and the minimum moisture for the growth of fungi and bacteria is sometimes a matter of only two or three per cent, and hence under certain climatic conditions microbiological decay is likely to be rapid and continuous. Thus the high humidity and temperature of the Tropics are ideal for microbial activity.

Cellulose materials, particularly in the form of textiles, wrappings for stores, and ropes for haulage, make up a large part of the equipment of war, and their destruction, which is a serious problem in peacetime, becomes even more serious in time of war. In at least one recent theater of hostilities in the Tropics, the relative humidity of the air never falls below 85 per cent. In such a damp atmosphere it is only a matter of hours before moulds grow freely, and, in some cases, of days before tents drop to pieces, packages burst open, cords decay, and equipment rots and corrodes. The financial loss in such circumstances is of relatively minor importance: much more serious are the wastage of shipping space, the loss of fighting equipment, and the endangering of men's lives.

It is these considerations of national security which give an impetus to the study of textile preservatives in wartime, although even before the war Britain's Department of

[1] With the permission of the British Broadcasting Corporation.

Scientific and Industrial Research and the various Textile Research Associations employed scientists to investigate various methods of treatments.

An obvious example of a textile needing protection from microbial attack is the jute sandbag. It is usually filled with earth, or earthy sand, and this happens to be the richest source of cellulose-destroying microbes. Furthermore, it is kept in conditions which encourage their development.

To try to find methods which will render sandbags and other fabrics immune to microbial attack, either temporarily or permanently, has meant much scientific research. But when we come to weed out these treatments which are unduly costly, or difficult to apply in bulk, or impracticable through nonavailability of materials, we are reduced to quite a number of possible methods of treatment. Which of these is most suitable depends on a variety of factors, such as the nature of the material to be treated, the conditions to which it will be exposed, and the purpose for which it is required.

Treatments generally embody the use of a substance poisonous to the microbes, and copper in some form is widely used. It may be employed as a copper soap, such as the naphthenate, dissolved in spirit, or as "cuprammo nium," which is a substance formed by the interaction of ammonia with copper salts, such as "blue vitriol." How much copper it is necessary to incorporate in the fabric or rope depends on the sort of treatment the material is going to get in service, but it is usual to aim at about one per cent of copper. This will not make the textile last for ever, but it will prolong its life many times.

Copper soaps such as the naphthenate, are soluble in creosote, and are sometimes applied in this form. The creosote itself gives added protection, although when used alone it does not prolong the life of a fabric sufficiently for some purposes.

A preservative popular in some quarters at present is known as "pentachlorphenol." But this substance has been criticized as being too volatile, and in some cases it is said to cause skin disease in those handling it.

Salts of zinc, cadmium, and chromium are sometimes advocated. Zinc is the oldest of these, but is ineffective unless used in almost absurdly high concentration. Cadmium seems to be inferior to copper, and chormium is only effective if applied in a special way.

Among "organic" chemicals, salicylanilide has been widely used, but has disadvantages: it is better against mildew fungi than against bacteria. A number of organic mercury compounds have been found quite efficacious, but their use on a large scale has not yet proved practicable.

Whatever preservative is selected for a particular job, the thoroughness of application is of the utmost importance. To be effective each individual fiber of the fabric should be coated with the preservative, and this is why, where it is possible, treatment of the yarn before weaving is advocated.—H. J. Bunker.

BOOK REVIEWS

AN INDIAN WAY TO PEACE

The Hopi Way. Laura Thompson and Alice Joseph. 151 pp. Illus. 1945. $3.00. The University of Chicago Press.

THE Hopi Pueblo Indians of northeastern Arizona are probably the best known Indians in America. They have long been known to the layman principally on account of their spectacular ceremony in which dancers hold live, writhing snakes—including rattlers—in their mouths and hands. And anthropologists have been carrying on studies of the Hopi for more than fifty years. But most of these studies have dealt with Hopi culture—with ceremonies, rituals, paraphernalia, social organization, and mythology—rather than with the people themselves as human beings and individuals. This book undertakes to do precisely this.

One hundred and ninety Hopi school children between the ages of 6 and 18 years, from two communities, were intensively studied. In addition to medical examinations, general observation, information from parents and teachers, the children were given a series of eight psychological tests, ranging from the Grace Arthur Point Performance Scale to the Rorschach (Inkblot) Test. Brief sketches of eleven children are presented. The results of the tests and observations are then discussed in an effective and illuminating manner.

The I.Q. of Hopi children, as measured by two tests, was considerably higher (11 to 16 per cent) than that of the white children upon whom the tests were standardized. The Rorschach test showed that the "mental approach" of Hopi children of six and seven years of age is much closer to that of white adults than to children of whites. Dr. Joseph once speaks of Hopi children as "adults in miniature" and of the Hopi in general she says:

"In dealing with the Hopi it would indeed be a grave mistake to adopt a baby-talk and the oversimplified methods which are so often used toward half-witted persons and those who go under the collective name of 'natives'."

Just as the adult Hopi are skillful and industrious, in contrast with a common conception of "the Indian" as shiftless and lazy, so does the life of the children differ from the picture of happy carefree "children of nature" that many people entertain. There is much gaiety and satisfaction in the lives of Hopi children, to be sure. But there are tensions, anxieties, and frustrations in abundance. There are, however, very few, if any, real neurotics among the Hopi. It is interesting to note that many children who have to outward appearance made satisfactory adjustments to their situations are, however, according to their tests, confused, unsatisfied and insecure in their inner lives. The tests also show that some children who were thought to be deaf, dumb, or stupid are really alert and intelligent, but maladjusted.

The personalities of Hopi children are much like those of white children in many respects; the same sort of desires, satisfactions, and frustrations that we are familiar with are found in their lives as well. But Hopi children differ from white American children at many points, too. They appear to be "deeply disciplined, to an extent which is truly astonishing." This seems to be due to the greater extent of group control in their society than in ours. There is twenty-five times as much fear of the supernatural among them as among white children. Personal failure and inadequacy is rather lightly regarded by the Hopi as compared with the white child. Personality difficulties encountered by the Hopi child are much less concerned with sex than is the case in our society.

The authors take much pains to relate their study of personality to the general cultural and environmental situation. The first three chapters acquaint the reader with Hopi history, habitat, and way of life. The presentation of the personality sketches is followed by an analysis in which personality is related to culture. Their picture has both breadth and insight.

Drs. Thompson and Joseph occasionally link up their study of these Indian school children of the remote and arid mesas of Arizona with world affairs, with the "dis-

astrous appeasement policy . . . at Munich," and with "scientific social planning for world peace," etc., which seems a bit extravagant to say the least. Their more modest and immediate objective, however, is to provide a more intelligent basis and a more efficient means of administration of Indian affairs in particular and of White-Indian relationships in general. This is both commendable and sound. But a glance at their figures on nutrition (48.4% undernourished; 41.8% suffering from malnutrition in one community) and for disease and death rates (25 per 1,000 for Hopi, 10.5 for the United States; infant mortality, 180 per 1,000 live births for Hopi, 41 for the United States) inclines one to think that what the Hopi need (if we are to help them) more than refined personality analysis is good food, decent sanitation, and adequate medical care. Although hardworking and economical, the people live in poverty and chronic hunger and without adequate medical care. While we do not wish for a second to belittle "depth psychology" and technical personality analysis, we are inclined to think that the Hopi have more to gain from improved diet than from results of Inkblot tests; more from improved sanitation and better medical care than from an application of Murray's Thematic Apperception Test. As a matter of fact, the analysis of personality and character so ably presented here suggests that if the fear of sickness and death could be lessened by improved nutrition and medicine, and if the fears and anxieties bred by poverty and insecurity could be minimized by improvement of economic status, the Hopi personality could take care of itself.

The Hopi Way was printed at Haskell Institute and is illustrated with many superb photographs.

LESLIE A. WHITE
DEPARTMENT OF ANTHROPOLOGY,
UNIVERSITY OF MICHIGAN

CANADIAN GEOGRAPHY

Le Canada Par L'Image. B. Brouillette. 133 pp. Illus. 1944. $1.00. Beauchemin Library, Montreal, Canada.

PROFESSOR BROUILLETTE'S book, now in its third edition, has served a very useful purpose in French-speaking Canada. Geography in Canadian schools has very often been taught in a static and unscientific way. So that this little book can serve as an introduction to geography in the modern sense. The approach to subject matter proceeds from the known and the immediate to the unknown and more remote. In the first chapter, an appeal is made to the reader's experience, and the author especially has in mind the immature reader for whom the book was primarily written. A description of Montreal involves physical, human, and economic factors in the order named. Although no technical or pedantic vocabulary are used, scientific method is implicit and furnishes the reader with an opportunity to assemble his facts in an altogether new light.

Having thus established the observational and deductive basis of geographical description in an area well known to the reader, the author proceeds to enlarge the horizon, in the following chapters, to the Province of Quebec and to Canada.

The text is very attractively illustrated with photographs showing the salient points of geographical interest, now centering around urban communities and now around wildlife and forests. Maps and tables are presented to summarize distributional and economic factors.

Although the book is meant for young readers, its method and scope make it interesting to the more mature who will not fail to appreciate the author's excellent style and his gift for synthesis.

PIERRE DANSEREAU
UNIVERSITY OF MONTREAL

HANDBOOK OF HOOSIER WEATHER

Climate of Indiana. S. S. Visher. 511 pp. Illus. 1944. Indiana University, Bloomington.

DR. VISHER had already shown his indefatigable zeal for climatic researches in his studies of the climates of South Dakota, Kentucky, and Australia, each published by the governments concerned, as well as by many other of his climatic volumes and papers. The present generous volume, of more than 500 pages, gathers together a wealth of information concerning the climate of Indiana, and its bearing on social and economic concerns. Although crammed with statistical information, this is to a great extent contained in maps with contour lines and shad-

ing, where he who runs may read. Tables, however, are given for climatic factors of some of the more important locations. It is impossible to give a fair impression of the enormous variety of facts which the volume contains. Very curious things crop out, such, for instance, as that both the highest and the lowest recorded temperatures of the State, 116° and −33° Fahr., occurred in the same locality in Northwestern Indiana. Again, the annual damage by lightning, in which Indiana is about average among the larger Northeastern States, amounts to nearly a half million dollars. Thousands of live stock are killed by lightning in the State annually, but the annual human death rate by lightning for Indiana and the East-North-Central States is only 2.1 per million.

A summary of the book is given in the 51 pages of the first chapter. The remaining 26 chapters are filled with detailed information, not only of the type usually published regarding climatic factors, but they inform us of the exceptional cases, the relations of climate to crops, to health, to pleasure, and to subjects that would seldom occur to the reader. Indiana citizens of all kinds will find it a treasure store for their advantage.

C. G. Abbot

Smithsonian Institution,
Washington, D. C.

METHODS IN MATHEMATICS

Psychology of Invention in the Mathematical Field. Jacques Hadamard. 143 pp. 1945. $2.00. Princeton University Press.

An eminent French mathematician, after a lifetime of mathematics, examines the "psychology of invention in the mathematical field," which he distinguishes from the "psychology of mathematical invention." The introductory remarks on the difference between invention and discovery seem to imply that Professor Hadamard is not a Platonic realist in his mathematics. For brevity only, this difference is ignored in what follows; if desired, "invention" may be substituted for "discovery."

The two previous contributions to the subject most frequently cited in studies of this kind are the questionnaire (1902, 1904) by *L'Enseignement Mathématique* concerning the working methods of mathematicians and Poincaré's account, inspired by the questionnaire, of how some of his most striking discoveries came to him almost unsought after a period of intense application. If any general conclusion is to be drawn from these and similar observations by individual mathematicians, it may be nothing more startling than the accepted remark that inspiration is nine-tenths perspiration. Flashes of insight but seldom perturb the indolent.

But sweat alone does not make mathematical discoveries. What does? Whoever professes to answer that may be invited to certify his answer by making a discovery. Professor Hadamard has a long list of discoveries to his credit, most of them familiar to all mathematicians. Yet in his modest and extremely interesting account of how he himself came upon some of his discoveries, he seems to be as far in the dark as the majority who make no discoveries, for all their hard labor. One point is of particular interest, and may be significant: with candor unusual in a mathematician, Professor Hadamard tells how more than once he failed to notice a discovery that was actually implicit in his work, recognizing it and appreciating its value only after others had found and exploited it independently. Unlike the retrospective historian of mathematics who detects anything from the calculus to transfinite induction in medieval theology, Professor Hadamard has never claimed priority for discoveries which, with just a little luck, might easily have been his.

The book is so packed with interesting case histories and critical evaluations of the lessons they teach—or fail to teach—that it is impossible to summarize them in a brief notice and a few indications must suffice. As might be expected, the "unconscious" and its relation to the subsequent "conscious" phase of invention is discussed at some length. Behaviorists may be interested in the various opinions on "words and wordless thoughts," where it appears that mathematical thought may not be just another instance of talking to oneself. The preferences for symbolism, whether geometric, algebraic, verbal, auditory, visual, or none at all, are not always what might be anticipated. Here, individuality precludes uniformity.

Although mathematics is no longer identi-

fied with logic as it was by some logicians a generation ago, it is still the most logical of the sciences. But few mathematicians will be astonished to learn that the part played by logic in mathematical discovery is sometimes indiscernible. A few may resent the frank disclosure of another trade secret: diagrammatic aids to reasoning, remembered while lecturing, frequently enable a skilled technician to bedazzle his unsuspecting audience with rigidly arithmetized proofs of quite profound propositions, for example in the theory of points sets. In the suppressed diagram the proposition may be intuitively evident and also, occasionally (for which God be praised), false. Professor Hadamard has found these visual intuitions helpful in recalling the logical details of subtle and complicated proofs. In much the same way, simple classical theorems and familiar concepts when abstracted and generalized in the modern manner, take on an impressive abstruseness which might seem less profound if the generalizing mathematician were unsophisticated enough to confess that he had merely doodled the obvious. The effect, however, would be less spectacular. As Poincaré observed, it is the man, not the method, that solves a real problem.

Under "paradoxical cases of intuition," Professor Hadamard instances Fermat's last theorem and Riemann's zeta hypothesis. It might seem unfair to some critics to include the first of these as an example of intuition—guessing, to give it a blunter name. Some who have examined the evidence favor the alternative hypothesis that Fermat was simply a better arithmetician than his successors. A more astonishing paradox than either of these was the false intuition of another first-rank arithmetician, Gauss, whose intuition, backed by extensive calculation, misled him to an erroneous conjecture concerning the relative frequency of primes of certain forms. But Gauss was temporarily safe in his mistaken belief. Had he calculated for a billion billion years, we would have come no closer to the truth his intuition concealed from him. So the intuition of great mathematicians may be about as real as the mythical intuition of women.

The book should be digested by anyone intending to make his living at mathematics. Although Professor Hadamard points no morals, several are plain. Three will be enough here. First, if you would make a mathematical discovery, work, and don't be too sanguine about making a discovery, no matter how hard you work. Second, unless you have an active and powerful imagination, keep away from mathematics.

The third moral suggests a project well within the existing techniques of psychology. If carried out, something definite—not much, perhaps, but still something—might be learned about the advanced training of mathematicians in the United States. "Students have often consulted me," Professor Hadamard relates, "for subjects of research; when asked for such guidance, I have given it willingly, but I must confess that—provisionally, of course—I have been inclined to classify the man as second rate. In a different field, such was the opinion of our great Indianist, Sylvain Levi, who told me that, on being asked such a question, he was tempted to reply: Now, my young friend, you have attended our courses for, say, three or four years and you have not perceived that there is something wanting further investigation?" Do the membership lists of the mathematical societies, especially those which state the institutions from which the members obtained their degrees, suggest that "there is something wanting further investigation?" How many mathematicians still mathematically active five years after their degrees chose their own subjects for their dissertations, and how many had subjects thrust upon them? How many of the inactive acquired a lasting distaste for research from having unpalatable topics rammed down their throats by egotistical professors concerned chiefly with founding a 'school' to glorify their own names for half a generation? To be of any psychological or educational value, an investigation of this sort should be searching and rude.

The mathematical layman will find Professor Hadamard's stimulating book fascinating reading unencumbered by incomprehensible technicalities. Only one misprint need be noted "Jessie" for "Jesse."

E. T. Bell

Department of Physics,
California Institute of Technology

CAUSES OF CRIME

Crime and the Human Mind. David Abrahamsen. 244 pp. 1944. $3.00. Columbia University Press, New York.

CRIME, like the poor, is always with us. For various reasons, however, as a subject it is by far a better "seller" than poverty or almost any subject except war (which is itself a sort of international crime!). This being the case, the present volume ought to be in great demand, for it deals with crime and (far more important) the criminal. One of the reasons why the treatment of the criminal has in general proved unsatisfactory is that attention has been focused on the crime rather than on the motivations and mental states of the criminal. It is to this thesis that Doctor Abrahamsen devotes himself.

The author is a Norwegian psychiatrist, experienced in criminological work both in his native country and here. He is now on the staff of the Psychiatric Clinic of the Court of General Sessions of New York City, the largest criminal court of general jurisdiction in the United States. Although he has been in this country only a few years, he exhibits an excellent grasp of the American crime problem, together with a broad continental and English background. He discusses, among other subjects, The Mind in Relation to Crime (Ch. 2), The Psychology of the Individual Offender and Classification (Ch. 6), Juvenile and War Delinquency (Ch. 7), and The Psychiatrist and the Criminal Law (Ch. 8).

His approach is that of the student of human behavior, who recognizes the need of scientific study of the offender's mental state if society is to be adequately protected and justice done to the individual—an approach which has steadily been gaining ground in the penological field for the past few decades. He points out the rôle of unconscious drives as well as the environmental factors, heredity, intellectual level, and the varied other influences which impinge upon the individual, be he criminal or churchman. The understanding of human behavior (the subject-matter of psychiatry) has made much progress, but its applicability to the group denominated "criminal" has lagged, partly on account of society's fear and hatred of the offender. Doctor Abrahamsen reminds us, "Mental patients were first placed in hospitals not for treatment but for the protection of society. The same is true of most offenders today. Prisons were built to provide housing for the prisoners with little or no treatment available."

The book is clearly written, and with very few exceptions is nontechnical in its language. Here is a challenging presentation of a vital subject which should be of interest to every thoughtful citizen.

WINFRED OVERHOLSER, M.D.
SAINT ELIZABETHS HOSPITAL,
WASHINGTON, D. C.

EDWARD BELLAMY—REFORMER

Edward Bellamy. Arthur E. Morgan. 468 pp. Illus. 1944. $5.00. Columbia University Press, New York.

THE reviewer finds it very difficult to put down in any exact form the impressions this book makes on him. It is a pleasure to review it because of its great excellence. Because of the limitations of space and not to deal too much in abstractions, he will confine his remarks here to the statement of a few of the characteristics of the book which make it a delight to this biography.

In the first place, this is a scholarly work, but it is not pedantic. It leaves one with the feeling that Dr. Morgan has searched diligently for all the facts which might throw light on the development of Bellamy's character and ideas, but he has not buried his interpretations in a mass of irrelevant details which would only bewilder the reader and leave him with a confused picture of Edward Bellamy and his work. Dr. Morgan has shown that one can be a scholar and yet not be tedious.

Secondly, the objectivity of treatment is refreshing. Although Dr. Morgan greatly admires Bellamy both as a man and as a thinker, he does not let this blind him to facts or bias his interpretation of Bellamy's life and writings. His selection of facts for this purpose is so careful and yet so unostentatious that one scarcely realizes it as he reads, and yet at the end one has confidence in the author's integrity and objectivity. Even on highly controversial points he maintains the detached attitude of the true scientist. The reviewer never found himself bracing his mind against distortions of fact.

A third characteristic of this biography is a broad and humanistic tolerance for views and weaknesses which might well have been made the object of bitter and unfair attack. This tolerance arises from what seems to the reviewer to be a deep understanding of the factors moulding the life of Bellamy. It is not just that "to know all is to forgive all," it is rather that as a biographer Dr. Morgan believes that his duty is that of an expositor rather than that of an advocate. He does not feel, therefore, that he needs to generate heat to destroy views with which he may not agree as long as he makes the reader understand the forces at work in the life of Edward Bellamy.

Finally, not because there is an end to the characteristics of this book which might profitably be enumerated, but because space is limited, it seems a *wise* book. Dr. Morgan has found a congenial subject in Edward Bellamy and has used this subject not only to present a picture of the man and his work but as a means of presenting his own outlook on life. This is meant as high praise. It has always seemed to the reviewer that a biography which did not contain a large portion of the biographer as well as his subject was both poor biography and social science—a mere pot boiler, or even the exploitation of a reputation by the writer or his publisher. This biography is certainly a "labor of love" as far as Dr. Morgan's attitude toward Bellamy is concerned, but it is also the matured and thoughtful expression of the author on the social and economic matters which occupied much of the life of Edward Bellamy. Dr. Morgan far from abusing the privileges of a biographer has used them to help us to understand the social order Edward Bellamy wished to reform which is not so essentially different from our own. In doing so he has put the very best of himself into the book and thus has opened his own experiences to the reader. That this is done largely unconsciously makes his exposition all the more effective. That the reviewer found the revelation of Dr. Morgan's personality almost as interesting as Bellamy's is only proof to his mind of a first-class job all the way through and is not meant to imply that Bellamy was neglected. He cannot see how a good biography, an understanding exposition of a man's life, can be much less revealing of the author than of the subject.

It is to be hoped that Dr. Morgan's *Edward Bellamy* will find a large group of readers. It is a social document of high value and withal is easy to read.

WARREN S. THOMPSON
SCRIPPS FOUNDATION FOR RESEARCH IN POPULATION PROBLEMS, MIAMI UNIVERSITY

THE WINGLESS AIRPLANE

Pioneering the Helicopter. C. L. Morris. 160 pp. Illus. 1945. $2.75. McGraw-Hill Book Company, New York and London.

THE book is a very interesting description of personal experiences of Mr. Morris and his collaborators while helping to develop Sikorsky helicopters. More so it was Mr. Morris's job to develop the proper technique to fly these machines and to teach others to fly them. To give a more vivid picture it has many illustrations in the form of sketches and photographs which help to show the progressive steps made in design and development of rotary wing aircraft. The author also gives an historical review of the general development of aircraft of this type. There is an excellent chapter in the book where the author describes in a very simple and clear way the principles of the helicopter and possible combinations of arrangement of the lifting rotors and control system. The book is especially interesting because of what the author had to put in, in helping to bring the machine to the modern state. One does not have to be technically inclined in order to find this book most fascinating to read.

A. A. NIKOLSKY
DEPARTMENT OF AERONAUTICAL ENGINEERING, PRINCETON UNIVERSITY

COMMENTS AND CRITICISMS

Mathematics for Thousands

In the article "The Character of Mathematics" by Harold L. Dorwart, appearing in the March issue of THE SCIENTIFIC MONTHLY, there is a listing of some of the more recent popular books on mathematics with the comment that "With the exception of *Mathematics for the Million*, by Lancelot Hogben, these books have probably reached only a limited number of readers."

It may be of interest to your readers and to Professor Dorwart to point out that the distribution of one of the volumes mentioned, *Mathematics and the Imagination*, has reached the respectable total of some 250,000 copies. This includes a printing for distribution to fighting men overseas. The large-scale distribution among our soldiers and sailors of popular books on science and mathematics offers real promise of a much widened interest in these subjects after the war is over.—JAMES R. NEWMAN.

The Cause Must Have Had Eyes

I should like to say a word or two about the excellently entitled article "The Cause Must Have Had Eyes" by Francis Sumner. Dr. Sumner commences his article by rejecting to some degree the Lamarckian speculations of Pauly as "fantastic," proceeds very wisely to show that the cause of natural selection, of protective coloration, must have had two pairs of eyes, the eyes of the predator as well as of the prey; lines up his own experiments in defense of natural, mechanistic, Darwinian selection; but concludes from his same experiments that there remain "physiological" (shall we not say psychobiological?) problems here that call for extensive future investigation."

In other words, there is an admitted conflict in Dr. Sumner's mind between his logical rejection of the idea of a peacock coloring its own tail, and his necessitated admission that simple natural selection is not sufficient explanation of the coloring of his fishes.

I believe that some light must be thrown on this conflict by logically considering any one of the many phrases such as "protective coloration," "protective selection," etc., in which the very word "protective" implies more than a mechanistic selection.

Protective coloration does take place. But why should it take place? If the fish were a stick, it would not take place. If the fish were any imaginable combination of active chemical ingredients, coloration might take place, but it would hardly be protective since its effect would be to render the ingredients inert. In other words, the very word "protective," the very fact of protection, implies some will on the part of the fish to be protected, to survive.

I am not suggesting that the will of the fish is the only factor governing its protective coloration. But I am suggesting that there is such a thing as "will" not yet otherwise definable, and that it operates in the preyed-upon fish to bring about, to set off a series of mechanistic changes which themselves provide the protection. It could not be otherwise, for, if it were, the willful word "protective" would be meaningless.

I am suggesting that what is truly evolutionary is the so-far indefinable will, and that Dr. Sumner's "psychobiological" problem lies in this direction. And I should like to know whether, and to what degree, the general health of the fish governs the degree and quality of protective coloration; because, if it does, it would seem logical, even as it already seems sensible, that there is such a thing as "will" and that it is a coefficient determined by a correlation of the normal condition of the several hereditary organs of the body, which coefficient when multiplied by the sum of the factors of environment at any one time might determine both the ability to survive and to some degree the quality of the survival.—MONTGOMERY HARE.

By logic and deduction, we surmise and theorize
On nature's technicolor viewed through human eyes.
One wonders where our theories would presently be hurled
If we knew just what an insect sees in its insect color-world!

—H. E. WOODCOCK.

Projective Geometry

May I call your attention to an odd error in the rather interesting article in the January number by N. A. Court. This contributor writes [page 65]:

". . . it is of great significance that the distinction between tactile geometry and visual geometry was not noticed by either philosophers or psychologists. Only after the patient labors of mathematicians created the doctrine of projective geometry did the distinction come to light. The credit for having pointed out this distinction goes to Federigo Enriques, Professor of Projective Geometry at the University of Rome."

The fact is that George Berkeley's *Essay towards a New Theory of Vision* (published 1709) has, for its main objective, the establishment of this very distinction. The *Essay* opens:

"My object is to show the manner wherein we perceive by sight the distance, magnitude and situation of objects. Also to consider the difference betwixt the ideas of sight and touch, and whether there be any idea common to both senses."—FREDERIC DREW BOND.

THE BROWNSTONE TOWER

ON PAGE 243 of the March issue the reader may have noticed some reflections of the editor's adviser, Hi Ho, a kindly but persistent Oriental who practices what he preaches. Despite his great age he retains to a remarkable degree his youthful spirit, vigor, and appearance, but his years are betrayed by his wisdom. Not for Hi Ho the follies of youth; he says, "Work! And let nothing interfere with its quality and quantity."

Having observed that the editor has heretofore written "The Brownstone Tower" in a cloud of cigarette smoke, Old Hi has gently remonstrated, but with the repetitive force of dripping water. The editor had to admit that he could not defend the habit, for it is demonstrably expensive, untidy, hazardous, and time-consuming, but he was afraid that twenty-five years of smoking had made it a necessary evil. Then, to his own astonishment and to the delight of Old Hi, he found that this column could be written in a smoke-free atmosphere.

Old Hi is noted for his rigorous thinking and adherence to his principles, but for all that he is not a cold intellectual machine; he has a soft spot that is touched by poetry. He has not revealed what he knows of the poetry of his native land, but with little provocation he will recite his favorite passages from Shakespeare, Milton, and Byron. He is particularly stirred by poems that snort defiance in the face of adversity, for he himself has the power and courage of a roused bull.

It is not surprising, therefore, that Old Hi favors the occasional publication of poetry in the SM. As for the editor, he fell in love with lyric poetry on a beautful campus in a springtime of long ago. "Oh, for one of those hours of gladness, gone, alas, like our youth, too soon." Now we must repress sentiment. In keeping with the purposes of the SM, we prefer to publish poems by scientists about science, but we will consider general poems by scientists and lay poems on science. Poems for the SM should not exceed thirty-two lines. An acceptable poem must have something to say and should say it musically and efficiently; the pattern of its composition should be pleasing to the ear, satisfying to the mind, and stimulating to the emotions. Accepted poems are published as fillers. After a given article we prefer to use a poem that has some bearing on it, and when suitable original poems are lacking, we sometimes get permission to reprint copyrighted poems.

On the third floor of the east wing of the Smithsonian Institution Building is the office of Mr. Paul H. Oehser, editor for the U. S. National Museum. Copy editing is not a stimulating occupation, but it has not yet quenched the creative fires in Mr. Oehser (pronounced ozier). He is a poet of exceptional ability, whose poems appear from time to time in Washington's *Post* and *Evening Star*. Fortunately for us, he takes an interest in the SM and has helped us not only in evaluating poetry but in other ways. His book reviews are among the best that have appeared in the SM. On one occasion he included in his review a stanza of verse that he attributed to his favorite poet. It was an admirably appropriate quotation. "And who," we inquired, "is your favorite poet?" "Paul Oehser," was the modest reply. We stand in envious awe of a man who can compose his own quotations as needed. As an example of the extraordinary felicity of his word patterns, reread "The Grapevine" (SM, Vol. 59, p. 244, 1944) with particular reference to the next to the last stanza.

Apparently the publication of poetry in the SM has not made a deep impression on our readers, for scarcely any letters of opinion regarding our poems have been received. Our policy has been noticed, however, by poets and rhymsters, and it is quite possible that its continuance may bring to light genuine poetical talent that might otherwise be lost to the world.—ED.

INDEX

CONTRIBUTORS

Principal Articles

ADAMS, R., Thoreau's Science, 379
ALBRECHT, W. A., Discrimination in Food Selection by Animals, 347

BATES, M., The Forest and the Sea, 383
BAWDEN, F. C., The Nature of Viruses, 48
BOUDREAU, F. G., The Problems We Face in Nutrition, 443
BOYD, T. A., Charles Franklin Kettering, 85
BOYER, C. B., Quantitative Science without Measurement, 358
BROWNE, C. A., Thomas Jefferson and Agricultural Chemistry, 55

CHAITKIN, J., The Challenge of Scientific Russian, 301
COLLIER, J. E., Artesian Water and Australia's Pastoral Industry, 117
COOKE, C. W., Neptune's Racetracks, 286
COURT, N. A., Geometry and Experience, 63

DAVIS, E. H., and E. Y. DAWSON, The Savage Seris of Sonora, I, 193; II, 261
DAVIS, J. J., The National Pest Control Association, 151
DAWSON, E. Y., see DAVIS, E. H.
DORWART, H. L., The Character of Mathematics, 177

GRUNDFEST, H., The Scientists' Postwar Problems, 130
GUDGER, E. W., Feline Fishermen, 89

HARRIS, C. D., The Ruhr, 25
HEDGPETH, J. W., Re-examination of the *Adventure of the Lion's Mane*, 227
HIGBEE, E. C., The River is the Plow, 405
HILTON, W. A., The Story of a Marine Laboratory, 213
HOFFLEIT, D., What Falls from Heaven, 30
HOOVER, J. E., FBI Laboratory in Wartime, 18

IRWIN, D. L., Agriculture in the Matanuska Valley of Alaska, 203

JANSSEN, R. E., Fossil Plant Miniatures of Mazon Creek, 187
JEFFRIES, Z., Metallurgy and the War, 67

KELLER, A. G., The Transplantation of Democracy, 165
KIRKPATRICK, F. H., A Look at Postwar Employment Adjustment, 254

LANCASTER, L. W., Liberal Education and the Study of Government, 388
LEAKE, C. D., Ethicogenesis, 245
LOBECK, A. K., Cartography, 417

MAHLIE, W. S., Good Water and Human Longevity, 455
MILLS, J., Electronics, 459

NEEDHAM, J. G., How Biology Came to Knox College, 365

PETERSON, A., Some Insect Infants, 426
PHILLIPS, R. W., Livestock in the Lives of the Chinese, 269
POLANYI, M., The Autonomy of Science, 141 (reprinted)

REMMERS, H. H., The Purdue Opinion Poll for Young People, 292
ROE, A., Alcohol Education in the Schools, 51

SCHMIDT, K. P., A Naturalist's Glimpse of the Andes, 335
SHAW, W. T., Wildlife Zones across Central California, 97
SHELLENBERGER, J. A., Argentina's Agricultural Future, 257
SKILLING, W. T., Our Revolving Island Universe, 108
SKUTCH, A. F., The Most Hospitable Tree, 5
SNYDER, E. E., It Might Have Been Banksia, 464
STRANDSKOV, H. H., The Rh Blood Factor, 451
SUMNER, F. B., The Cause Must Have Had Eyes, 181
SWAMINATHAN, V. S., Scientific and Industrial Research in India, 307

TAYLOR, G., Corridors into Germany, 353
TRYTTEN, M. H., The Impending Scarcity of Scientific Personnel, 37

VAILLANT, G. C., Shadow and Substance in Cultural Relations, 373

WELLS, W. F., Sanitary Ventilation by Radiant Disinfection, 325

YATES, P. L., The Marriage of Nutrition and Agriculture, 221

Science on the March

BEVAN, A., War Minerals—Mica, 393
BROMLEY, S. W., An Indian Relict Area, 153
BUNKER, H. J., The Protection of Textiles against Biological Decay, 471

DORWART, H. L., Perennial Mathematics, 72

LOW, A. M., Aircraft from the Sea, 73
LYONS, W. J., The New Division of High-Polymer Physics of the American Physical Society, 71

MACKINTOSH, N. A., Research in the Antarctic, 154
MEYER, B. S., Growth Regulators in Plants, 468

PARK, T., Ecological Aspects of Population Biology, 311
POTTER, T. S., Science and Tuberculosis, 467

REINEKE, E. P., see C. W. TURNER
ROBERTS, F. H. H., JR., An Early Texan, 392

STETSON, H. T., Dimout Reveals Secrets of the Nebulous Andromeda, 313

TUKEY, H. B., Hybrid Vegetable Seed, 391
TURNER, C. W., and E. P. REINEKE, Thyroprotein for Increased Milk and Egg Production, 233

Book Reviews

ABBOT, C. G., *Climate of Indiana*, by S. S. Visher, 474

BELL, E. T., *Psychology of Invention in the Mathematical Field*, by Jacques Hadamard, 475
BELL, W. B., *The Woods Hole Marine Biological Laboratory*, by Frank R. Lillie, 75
BLAYDES, G. W., *Practical Plant Anatomy*, by A. S. Foster, 80

CAPRIO, F. S., *Rebel without a Cause*, by Robert M. Linder, 235
CLEPPER, H., *Forestry on Private Lands in the United States*, by Clarence F. Korstian, 77

DANSEREAU, P., *Le Canada Par L'Image*, by B. Brouillette, 474
DOVE, W. E., *Mosquito Control*, (Revised Edition), by William B. Herms and Harold F. Gray, 238

GAFAFER, W. M., *American Medical Practice in the Perspectives of a Century*, by Bernhard J. Stern, 319
GRAUBARD, M., *A Source Book of Agricultural Chemistry*, by Charles A. Browne, 79; *University Records and Life in the Middle Ages*, by Lynn Thorndike, 239

HAUSMAN, L. A., *The Book of Naturalists*, edited by William Beebe, 159; *Joseph Lister, Father of Modern Surgery*, by Rhoda Truax, 397
HEDGPETH, J. W., *Climate and the Energy of Nations*, by S. F. Markham, 159; *One Day on Beetle Rock*, by Sally Carrighar, 315

KELLER, A. G., *Social Darwinism in American Thought, 1860–1915*, by Richard Hofstadter, 398

LEAKE, C. D., *Science in Soviet Russia*, published by the National Council of American-Soviet Friendship, 397

MERRILL, E. D., *Foundations of Plant Geography*, by Stanley A. Cain, 76
MONTAGU, A., *The Royal Society, 1660–1940*, by Sir Henry Lyons, 401

NIKOLSKY, A. A., *Pioneering the Helicopter*, by C. L. Morris, 478

OEHSER, P. H., *Electronics: Today and Tomorrow*, by John Mills, 158; *Men of Science in America*, by Bernard Jaffe, 237
OVERHOLSER, W., *Crime and the Human Mind*, by David Abrahamsen, 477

PRICE, J. W., *Amphibians and Reptiles of the Chicago Area*, by Clifford H. Pope, 399

RENSHAW, S., *Personality and the Behavior Disorders*, edited by J. McV. Hunt, 235
ROBINSON, H. B. G., *Costs of Dental Care for Adults under Specific Clinical Conditions*, by Dorothy Fahs Beck assisted by Mary Frost Jessup, 157

SAX, K., *Enough and to Spare*, by Kirtley F. Mather, 316; *Demographic Studies of Selected Areas of Rapid Growth*, published by the Milbank Memorial Fund, 316
SCHMIDT, K. P., *Guide to Higher Aquarium Animals*, by Edward T. Boardman, 402
SINCLAIR, J. G., *Ourselves Unborn*, by George W. Corner, 160
SWINGLE, M. C., *That Vanishing Eden: A Naturalist's Florida*, by Thomas Barbour, 401

THOMPSON, W. S., *Edward Bellamy*, by Arthur E. Morgan, 477

VOKES, H. E., *Geology for Everyman*, by Sir Albert Seward, 315

WADE, J. S., *Ventures in Science of a Country Surgeon*, by Arthur E. Hertzler, 400
WADLEY, F. M., *Consider the Calendar*, by Bhola D. Panth, 318
WHITE, L. A., *The Hopi Way*, by Laura Thompson and Alice Joseph, 473

Original Verse

JORDAN, E. P., Dominion, 116

SINCLAIR, J. G., Ajax, 54; Electra, 306

WOODWARD, G., The Philosopher, 232

Comments and Criticisms

BAIN, R., Social Sciences, Too!, 321
BOND, F. D., Projective Geometry, 479
BOWER, W. C., Science and Social Wisdom, 83
BRANDWEIN, P. F., An Obstacle to a Science of Education, 81
BREWER, W. F., Feline Fishermen, 321
BROCKETT, P., Additional Medalists, 163
BROWNE, C. A., Omission, 321

DAWSON, J. C., Lakanal and Chappe's Telegraph, 322
DEWEY, J., Science and Social Wisdom, 83

ELLWOOD, C. A., Science and Social Wisdom, 83

GOOD, H. G., Correction, 323

HARE, M., The Cause Must Have Had Eyes, 479
HARPER, R. M., Manuscript Famine!, 243

JOHNSON, P. B., Multiple Hypotheses, 163

LENZ, R. E., Culture, 83

MCKAVITT, M. A., Science and Social Wisdom, 83

MACKAY, A. D., On Top Down Under, 243
MILLER, E. R., Meteors and Meteorology, 403
MONTAGU, A., Mr. Simple on Racial Equality, 241

NEWMAN, J. R., Mathematics for Thousands, 479

OLD HI HO, To Honorable Writers, 243

PILCHER, J. F., Leishmaniasis in Texas, 83
POTTER, A. A., Duelism, 83

SCHOER, N., To Dr. Court on Space, 243
SHAPIRO, S. R., Carter, not Carver, 83
STECHER, R. M., On Meeting the Authors, 162
STEWART, H. L., Approval, 323

URDANG, G., The Golden Eggs, 161

WADE, J. S., On "The Brownstone Tower," 321
WHITE, L. A., Galileo vs. Aristotle, 403
WOODCOCK, H. E., The Cause Must Have Had Eyes, 479

SUBJECT INDEX

Principal Articles

Adventure of the Lion's Mane, Re-examination of the, J. W. HEDGPETH, 227
Agriculture in the Matanuska Valley of Alaska, D. L. IRWIN, 203
Agriculture, The Marriage of Nutrition and, P. L. YATES, 221
Agriculture (Argentina's Agricultural Future), J. A. SHELLENBERGER, 257; (The River is the Plow), E. C. HIGBEE, 405
Alcohol Education in the Schools, A. ROE, 51
Andes, A Naturalist's Glimpse of the, K. P. SCHMIDT, 335
Animals, Discrimination in Food Selection by, W. A. ALBRECHT, 347
Argentina's Agricultural Future, J. A. SHELLENBERGER, 257
Artesian Water and Australia's Pastoral Industry, J. E. COLLIER, 117
Astronomy (What Falls from Heaven), D. HOFFLEIT, 30; (Our Revolving "Island Universe"), W. T. SKILLING, 108
Autonomy of Science, The, M. POLANYI, 141

Banksia, It Might Have Been, E. E. SNYDER, 464
Biology (How Biology Came to Knox College), J. G. NEEDHAM, 365
Blood Factor, The Rh, H. H. STRANDSKOV, 451

Cartography, A. K. LOBECK, 417
Cause Must Have Had Eyes, F. B. SUMNER, 181
Challenge of Scientific Russian, J. CHAITKIN, 301
Character of Mathematics, The, H. L. DORWART, 177
Charles Franklin Kettering, T. A. BOYD, 85
Chemistry, Thomas Jefferson and Agricultural, C. A. BROWNE, 55
Chinese, Livestock in the Lives of the, R. W. PHILLIPS, 269
Corridors into Germany, G. TAYLOR, 353
Cultural Relations, Shadow and Substance in, G. C. VAILLANT, 373

Democracy, The Transplantation of, A. G. KELLER, 165
Disinfection, Sanitary Ventilation by Radiant, W. F. WELLS, 325

Education, Alcohol, in the Schools, A. ROE, 51
Education, Liberal, and the Study of Government, L. W. LANCASTER, 388
Electronics, J. MILLS, 459
Employment Adjustment, A Look at Postwar, F. H. KIRKPATRICK, 254
Entomology (The National Pest Control Association), J. J. DAVIS, 151; (Some Insect Infants), A. PETERSON, 426
Ethicogenesis, C. D. LEAKE, 245
Ethnology (The Savage Seris of Sonora), E. H. DAVIS and E. Y. DAWSON, 193, 261

FBI Laboratory in Wartime, J. E. HOOVER, 18
Feline Fishermen, E. W. GUDGER, 89
Food Selection by Animals, Discrimination in, W. A. ALBRECHT, 347
Forest and the Sea, The, M. BATES, 383
Fossil Plant Miniatures of Mazon Creek, R. E. JANSSEN, 187

Geography (The Ruhr), C. D. HARRIS, 25
Geology (Neptune's Racetracks), C. W. COOKE, 286
Geometry and Experience, N. A. COURT, 63
Germany, Corridors into, G. TAYLOR, 353
Good Water and Human Longevity, W. S. MAHLIE, 455
Government, Liberal Education and the Study of, L. W. LANCASTER, 388

Impending Scarcity of Scientific Personnel, The, M. H. TRYTTEN, 37
India, Scientific and Industrial Research in, V. S. SWAMINATHAN, 307
Insect Infants, Some, A. PETERSON, 426
It Might Have Been Banksia, E. E. SNYDER, 464

Jefferson, Thomas, and Agricultural Chemistry, C. A. BROWNE, 55

Kettering, Charles Franklin, T. A. BOYD, 85
Knox College, How Biology Came to, J. G. NEEDHAM, 365

Laboratory, FBI, in Wartime, J. E. HOOVER, 18
Livestock in the Lives of the Chinese, R. W. PHILLIPS, 269

Marine Laboratory, The Story of a, W. A. HILTON, 213

Matanuska Valley of Alaska, Agriculture in the, D. L. IRWIN, 203
Mathematics, The Character of, H. L. DORWART, 177
Metallurgy and the War, Z. JEFFRIES, 67

Natural History (The Most Hospitable Tree), A. F. SKUTCH, 5; (Wildlife Zones across Central California), W. T. SHAW, 97
Naturalist's Glimpse of the Andes, A, K. P. SCHMIDT, 335
Nature of Viruses, The, F. C. BAWDEN, 48
Neptune's Racetracks, C. W. COOKE, 286
Nutrition and Agriculture, The Marriage of, P. L. YATES, 221
Nutrition, The Problems We Face in, F. G. BOUDREAU, 443

Opinion Poll for Young People, The Purdue, H. H. REMMERS, 292

Pest Control Association, The National, J. J. DAVIS, 151
Physics (Quantitative Science without Measurement), C. B. BOYER, 358
Plant Miniatures of Mazon Creek, Fossil, R. E. JANSSEN, 187
Postwar Problems, The Scientists', H. GRUNDFEST, 130
Problems We Face in Nutrition, The, F. G. BOUDREAU, 443

Quantitative Science without Measurement, C. B. BOYER, 358

Re-examination of the *Adventure of the Lion's Mane*, J. W. HEDGPETH, 227
Rh Blood Factor, The, H. H. STRANDSKOV, 451
River is the Plow, The, E. C. HIGBEE, 405
Ruhr, The, C. D. HARRIS, 25
Russian, The Challenge of Scientific, J. CHAITKIN, 301

Sanitary Ventilation by Radiant Disinfection, W. F. WELLS, 325
Science, The Autonomy of, M. POLANYI, 141
Scientific and Industrial Research in India, V. S. SWAMINATHAN, 307
Scientific Personnel, The Impending Scarcity of, M. H. TRYTTEN, 37
Scientists' Postwar Problems, The, H. GRUNDFEST, 130
Sea, The Forest and the, M. BATES, 383
Seris, The Savage, of Sonora, E. H. DAVIS and E. Y. DAWSON, 193, 261
Shadow and Substance in Cultural Relations, G. C. VAILLANT, 373
Story of a Marine Laboratory, The, W. A. HILTON, 213

Thoreau's Science, R. ADAMS, 379
Transplantation of Democracy, A. G. KELLER, 165
Tree, The Most Hospitable, A. F. SKUTCH, 5

Universe, Our Revolving Island, W. T. SKILLING, 108

Ventilation, Sanitary, by Radiant Disinfection, W. F. WELLS, 325
Viruses, The Nature of, F. C. BAWDEN, 48

Water, Good, and Human Longevity, W. S. MAHLIE, 455
What Falls from Heaven, D. HOFFLEIT, 30
Wildlife Zones across Central California, W. T. SHAW, 97

Science on the March

Aircraft from the Sea, A. M. LOW, 73
American Physical Society, The New Division of High-Polymer Physics of the, W. J. LYONS, 71
Antarctic, Research in the, N. A. MACKINTOSH, 154
Astronomy (Dimout Reveals Secrets of the Nebulous Andromeda), H. T. STETSON, 313

Biological Decay, The Protection of Textiles against, H. J. BUNKER, 471

Early Texan, An, F. H. H. ROBERTS, JR., 392
Ecological Aspects of Population Biology, T. PARK, 311

Growth Regulators in Plants, B. S. MEYER, 468

Hybrid Vegetable Seed, H. B. TUKEY, 391

Indian Relict Area, An, S. W. BROMLEY, 153

Mathematics, Perennial, H. L. DORWART, 72
Mica, War Minerals—, A. BEVAN, 393

Nebulous Andromeda, Dimout Reveals Secrets of the, H. T. STETSON, 313

Perennial Mathematics, H. L. DORWART, 72
Physics, High-Polymer, The New Division of, of the American Physical Society, W. J. LYONS, 71
Plants, Growth Regulators in, B. S. MEYER, 468
Population Biology, Ecological Aspects of, T. PARK, 311
Production, Milk and Egg, Thyroprotein for Increased, C. W. TURNER and E. P. REINEKE, 233
Protection of Textiles against Biological Decay, The, H. J. BUNKER, 471

Research in the Antarctic, N. A. MACKINTOSH, 154

Science and Tuberculosis, T. S. POTTER, 467
Sea, Aircraft from the, A. M. LOW, 73

Texan, An Early, F. H. H. ROBERTS, JR., 392
Thyroprotein for Increased Milk and Egg Production, C. W. TURNER and E. P. REINEKE, 233
Tuberculosis, Science and, T. S. POTTER, 467

Vegetable Seed, Hybrid, H. B. TUKEY, 391

War Minerals—Mica, A. BEVAN, 393

A photograph taken at a demonstration at Bell Telephone Laboratories, Murray Hill, New Jersey

U. S. invention helps shoot down Robot Bombs

The electrical gun director is one of Bell Telephone Laboratories' many wartime developments. It is made by the Western Electric Company. It practically takes the guesswork out of aiming and shooting anti-aircraft guns.

When artillery equipped with electrical gun directors moved up to England's buzz-bomb front, the picture changed for the better at once. Here's a typical day's record: One hundred forty-three bombs reached the coastline. The R.A.F. accounted for thirty-five, seventeen were downed by barrage balloons, and the artillery using electrical gun directors bagged sixty-five. Only twenty-six got through.

Bell Laboratories goes right ahead with war work until our infantry takes Tokyo. Then it goes back to its regular job—keeping American telephone service the best in the world.

BELL TELEPHONE SYSTEM

THE SCIENTIFIC MONTHLY

Vol. LX, No. 1 **JANUARY, 1945** **Whole No. 352**

An illustrated magazine broadly interpreting to the thoughtful public the progress of science and its relations to the problems confronting civilization. Published by the American Association for the Advancement of Science, Smithsonian Institution Building, Washington 25, D. C.

Edited by F. L. Campbell.

Editorial Advisers: John E. Flynn, D. R. Hooker, Kirtley F. Mather, and William J. Robbins.

Contributing Editors: William A. Albrecht, Arthur Bevan, L. V. Domm, Wilton M. Krogman, B. S. Meyer, Frank H. H. Roberts, Jr., Malcolm H. Soule, Edward J. Stieglitz, Harlan T. Stetson, and H. B. Tukey.

Address all correspondence concerning editorial matters to the Office of The Scientific Monthly, Smithsonian Institution Building, Washington 25, D. C.

Office of publication, North Queen St. and McGovern Avenue (The Science Press Printing Co.), Lancaster, Pa.

Subscriptions: The calendar year, $5.00; single numbers, 50 cents.

Orders for subscriptions and requests for changes of address should be directed to the Office of the Permanent Secretary of the Association, Smithsonian Institution Building, Washington 25, D. C. Two weeks are required to effect changes of address.

Copyright, 1945, by the American Association for the Advancement of Science.

Entered as second-class matter at the post office at Lancaster, Pa., U. S. A. July 18, 1923, under the Act of March 3, 1879.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Founding and Organization

In 1848, on September 20, the Association was formally organized and held its first meeting; in 1874 it was incorporated under the laws of the Commonwealth of Massachusetts and given the right to receive, purchase, hold and convey property. Its governing body is a Council, now having 255 members.

The Association is national in scope, with membership open to the whole world on equal terms, and its interests include the broad fields of the natural and the social sciences. Its varied activities are carried on under 16 sections with which 189 affiliated and associated societies, having a combined membership of nearly a million, cooperate in organizing programs for its meetings.

Members and Meetings

All persons engaged in scientific work, all who find pleasure in following scientific discoveries, all who believe that through the natural and social sciences a better society may be achieved are eligible for membership in the Association. From its founding, the most distinguished of American scientists, including every American Nobel Laureate in science and every president of the National Academy of Sciences, have been members. The names of many university presidents, of eminent scholars in widely different fields, and of men notable for public service, including a United States Senator, a Justice of the Supreme Court, and a former president of the United States, are now on its roll of more than 26,000 members.

The Association's meetings are field days of science attended by thousands of participants at which hundreds of scientists vie with one another for the pleasure and the honor of presenting results of researches of the greatest benefit to their fellow men. An enlightened daily press reports their proceedings throughout the country.

Opportunity and Responsibility

A world torn by conflicts and fearful of the future is looking more and more toward scientists for leadership. The opportunity for unparalleled service is theirs and the fact that they have available the only essentially new methods, if not purposes, imposes an equal responsibility. For these reasons it will be the Association's steadfast purpose to promote closer relations among the natural and the social scientists, and between all scientists and other persons with similar aspirations, to the end that they together may discover means of attaining an orderliness in human relations comparable to that which they find in the natural world about them.

MEET THE AUTHORS

ALEXANDER F. SKUTCH, Ph.D., is a modern Thoreau, for he has chosen to make his home in a remote tropical valley. His present address is San Isidro del General, Costa Rica. There he combines tropical agriculture with observations on the living things around him and writes on his observations in a manner that should cause examples of his work to be included in anthologies of natural history. For additional information see his brief autobiography on page 260 of the issue for April 1944.

JOHN EDGAR HOOVER, LL.D., Sc.D., D.C.L., is, as everyone knows, Director of the Federal Bureau of Investigation, U. S. Department of Justice, Washington, D. C. He was born on New Year's Day, 1895, in (of all places!) the District of Columbia and therefore is an outstanding example of the local boy who made good. His degrees in law were obtained from George Washington University and his honorary degrees from schools too numerous to mention. He has been admitted to practice law before the bar of the District Court of the United States for the District of Columbia, the United States Court of Claims, and the United States Supreme Court. Mr. Hoover entered the Department of Justice in 1917, and in 1919 was appointed Special Assistant to the Attorney General. From 1921 until 1924 he served as Assistant Director of the Bureau of Investigation and in May 1924 he was named Director. For his distinguished public service in the FBI, Mr. Hoover was awarded the Public Welfare Medal, for 1939, of the National Academy of Sciences—the medal that was illustrated on page 427 of the December 1944 issue. He is also the recipient of awards by many other organizations and he has been decorated by foreign governments for his leadership and co-operation in the law enforcement profession. Mr. Hoover takes a great interest in the development of American boys and girls and has received awards from both the Boy Scouts and the Camp Fire Girls. He is a trustee of his alma mater, George Washington University, and has many other civic responsibilities. Of course, he is an active or honorary member of numerous law enforcement associations and is a member of many clubs and fraternities.

MENTAL HEALTH

viii + 470 quarto pages
(7½ x 10½ inches)
illustrated, references

This volume, one of the Symposium Series sponsored by the Section on Medical Sciences, contains 51 papers, 20 invited formal discussions and 21 informal discussions. The main subject headings are—

I. Introduction (by Dr. Thomas M. Rivers)
II. Orientation and Methods in Psychiatric Research
III. Sources of Mental Disease: Their Amelioration and Prevention
IV. The Economic Aspects of Mental Health
V. Physical and Cultural Environment in Relation to the Conservation of Mental Health
VI. Mental Health Administration
VII. Professional and Technical Education in Relation to Mental Health
VIII. Human Needs and Social Resources (by Dr. C. Macfie Campbell)

Published in 1939. $4.50

RELAPSING FEVER

vi + 130 quarto pages
(7½ x 10½ inches)
illustrated, references

Another of the Symposium Series, contains 20 papers covering subjects related to Relapsing Fever—parasitology, tick vectors, epidemiology, symptomatology, and the public health aspect. This volume is of immediate importance to public health officers and practicing physicians.

Published in 1942. $3.00

American Association for the Advancement of Science
Smithsonian Institution Building
Washington 25, D. C.

NEW BOOKS*

The Book of Naturalists. Edited by WILLIAM BEEBE. 499 pp. 1944. $3.50. Alfred A. Knopf, New York.

Our reviewer writes: "Dr. Beebe has just returned from another of his famous expeditions, bringing with him this time not objects from nature but the naturalists themselves who have written of them. . . . Acting as a sort of toastmaster-through-the-ages, he has called upon forty-five naturalists of his own selection to tell us a good story."

Joseph Lister, Father of Modern Surgery. RHODA TRUAX. 287 pp. Illus. 1944. $3.50. Bobbs-Merrill Co., Indianapolis.

The editor has actually read a large part of this book, and it was only need for sleep that prevented him from finishing it. He recommends it most highly as an intensely interesting story of a good man and his devoted wife and as an example of one of the most dramatic achievements in applied science.

That Vanishing Eden, A Naturalist's Florida. THOMAS BARBOUR. 250 pp. Illus. 1944. $3.00. Little, Brown & Co., Boston.

One of our most articulate naturalists reminisces about his intermittent life-long experiences in the State of Florida—the State that "ain't what she used to be." This book should be a joy to those whose interests in Florida are not "carnal," but who love nature undefiled.

Soul of Amber. ALFRED M. STILL. 274 pp. 1944. $2.50. Murray Hill Books, Inc., New York.

This is another book on electricity for "the intelligent layman," but instead of attempting to explain the latest in electronics, it goes back to the very beginning of the perception of electrical phenomena and develops the science of electricity up to the time of Faraday. Biography and philosophy help to illuminate the story.

One Day on Beetle Rock. SALLY CARRIGHAR. 196 pp. Illus. 1944. $2.75. Alfred A. Knopf, New York.

Nine species of animals that occur in Sequoia National Park are the subjects of the stories in this book, which is endorsed by Dr. Robert C. Miller, Director of the California Academy of Sciences. He says: "The tales are fiction, yes, but fiction closely parallel with fact. This is real natural history."

The Science of Man in the World Crisis. Edited by RALPH LINTON. 532 pp. 1945. $4.00. Columbia University Press, New York.

The purpose of this book is to shorten the time interval between the acquisition of knowledge by specialists on the science of man and the recognition of that knowledge by other scientists and the general public. The book consists of twenty-one essays contributed by leading anthropologists, sociologists, and other scientists whose knowledge can influence the future of man.

American Botany, 1873–1892, Decades of Transition. ANDREW DENNY RODGERS III. 340 pp. Illus. 1944. $3.75. Princeton University Press.

This is the fourth book by the author on the history of American botany. It might be regarded as a biography of Asa Gray, who was the dominant figure in botany during the period covered. As the author goes into great detail, quoting from letters of various botanists, this history would probably be of interest only to botanists.

* Orders for the books noticed above should not be sent to THE SCIENTIFIC MONTHLY or the A.A.A.S., but to your bookseller or the publisher.

MEET THE AUTHORS, Continued

CHAUNCEY D. HARRIS, Ph.D., was recently appointed Assistant Professor of Geography at the University of Chicago and is now on leave for military service as second lieutenant. As his assignment is of a confidential nature, his present address cannot be given. Born in Logan, Utah, in 1914, he is a graduate of Brigham Young University, of which his father is President. He studied as a Rhodes Scholar at Oxford University, 1934–36, and at the London School of Economics, 1936–37. During this time he traveled extensively in Europe, spending the month of September 1935 in the Ruhr, which he examined from the saddle of the same bicycle that carried him over much of western Europe. His present paper is the result of that experience. Taking his Ph.D. from the University of Chicago in 1940, he taught at Indiana University and at the University of Nebraska until 1942 when he was granted leave for work in the Division of Geography and Cartography, U. S. Department of State.

DORRIT HOFFLEIT, Ph.D., has been Research Associate at the Harvard College Observatory since 1938. In 1942 she was "called" to the Aberdeen Proving Grounds, Aberdeen, Maryland, for war work at the Ballistics Research Laboratory, where she is now supervising a crew of computers. Miss Hoffleit was born in Florence, Alabama, in 1907, grew up in New Castle, Pennsylvania, and attended high school and college (Radcliffe) in Cambridge, Massachusetts. At Radcliffe in 1938 she won her Ph.D. and the Caroline Wilby Prize for the "best original work [thesis] in any department." While still a graduate student she was employed at the Observatory as a research assistant. In 1938 Dr. Hoffleit attended a meeting of the International Astronomical Union in Stockholm, as a member of the Commission on Meteors. She is known for her research on variable stars and meteors and she writes "News Notes" for *Sky and Telescope*.

MEET THE AUTHORS, Continued

M. H. TRYTTEN, Ph.D., is Director of the Office of Scientific Personnel of the National Research Council, Washington, D. C., and is on leave of absence from the physics staff of the University of Pittsburgh. Of Norwegian ancestry, he was born at Albert Lea, Minnesota, in 1894 and graduated from Luther College in 1916. His service as instructor in physics at Luther College was interrupted by World War I, during which he served as a doughboy in France. After the Armistice he lived with a French family and attended Poitiers University for four months. He spent the year 1920–21 studying physics at the Royal Frederick University, Oslo, Norway, as American-Scandinavian Foundation Fellow. He took his master's degree at the State University of Iowa in 1924 and then joined the department of physics of the University of Pittsburgh where he taught until he came to Washington in 1941. While at Pittsburgh he took his Ph.D. in physics in 1928, specializing in magnetism, but his later interest was primarily in the teaching of physics, particularly in the high schools of Pennsylvania. Dr. Trytten's first assignment in Washington was as Technical Aide, O.S.R.D. In December 1942 he became Executive Officer, National Committee on Physicists, War Manpower Commission, and Principal Employment Specialist in Physics, National Roster of Scientific and Specialized Personnel. On July 1, 1944 he took his present position. The paper presented in this issue is a direct outgrowth of the work of the Office of Scientific Personnel, which concerns itself with problems of utilization of scientific personnel in the present emergency.

F. C. BAWDEN, M.A., is Head of the Department of Plant Pathology at Rothamsted Experimental Station, Hertfordshire, England, a position he has held since 1940. He was educated at Cambridge University where he was a scholar of Emanuel College. Prior to his appointment to his present position he held the post of Virus Physiologist at Rothamsted Research Office at the Potato Virus Research Station, Cambridge. (The British Information Services, who provided Mr. Bawden's manuscript, could give us no more information about him.)

AEROBIOLOGY

viii + 299 quarto pages
(7½ x 10½ inches)
illustrated, references

This volume, one of the Symposium Series, consists of 37 papers. Eight papers cover *extramural aerobiology* which is concerned with the distribution of living organisms by the exterior air and with some of the consequences of their distribution. Twenty-nine papers on *intramural aerobiology* cover (1) the problem of contagion by air-borne infectious materials, (2) expulsion of secretions from the mouth and nose, and (3) infections from dissemination of pathogenic organisms into the operating room, the hospital ward, the school and the home. Published in 1942. $4.00.

LABORATORY PROCEDURES
in Studies of
CHEMICAL CONTROL OF INSECTS

viii + 206 quarto pages
(7½ x 10½ inches)
illustrated, references

Another of the Symposium Series, containing 12 principal papers and 41 supplementary contributions on (1) rearing test insects, (2) rearing insects that attack stored products, (3) rearing insects affecting man and animals, (4) methods of testing insecticides against insects in the laboratory, and (5) statistical methods. Bibliography of 500 references. Two indexes, one of scientific names and the other of common names of insects. Published in 1943. $4.00.

American Association for the
Advancement of Science
Smithsonian Institution Building,
Washington 25, D. C.

MEET THE AUTHORS, Continued

ANNE ROE, Ph.D., is Research Assistant (with the rank of Assistant Professor) in psychology for the Section on Alcohol Studies of the Laboratory of Applied Physiology at Yale. She is the wife of Dr. George Gaylord Simpson, Associate Curator of Vertebrate Paleontology at the American Museum of Natural History. Dr. Roe was born in Denver in 1904, took her bachelor's and master's degrees from the University of Denver, and received her Ph.D. from Columbia. After early experience in college teaching and clinical psychology she has spent all her time in research, dealing with newborn infants and intelligence of normal and abnormal adults. Experienced in statistical methods, she has just completed a study on the outcome of children brought up by foster parents—children whose own parents were alcoholic, psychotic, or normal. Dr. Roe is a Vice President of the New York Academy of Sciences.

Harris & Ewing

CHARLES A. BROWNE, Ph.D., Sc.D., retired supervisor of chemical research in the former U. S. Bureau of Agricultural Chemistry and Engineering, was born in 1870 on a farm in Berkshire County, Massachusetts. He now resides at 3408 Lowell Street, Washington, D. C., and is engaged in writing a history of the American Chemical Society. It is unfortunate that space is lacking to give a full description of the career of this eminent chemist. Graduating in 1892 from Williams College, Dr. Browne became interested in sugar chemistry which he pursued for many years, first working with sugar beets at the Pa. Agr. Exp. Sta. and then taking his doctor's degree at Göttingen University, Germany, in 1902. Then he worked in Louisiana, Washington, and New York until he became chief of the U. S. Bureau of Chemistry in 1923. Dr. Browne is an excellent writer and scholar and is known not only for his publications on sugar analysis but for his writings on the history of science, particularly agricultural chemistry.

MEET THE AUTHORS, Continued

NATHAN ALTSHILLER COURT, Ph.D., is Professor of Mathematics at the University of Oklahoma, in charge of the chair of Modern and Projective Geometry. He was born in 1881 in Warsaw, at that time a part of the Russian Empire. Barred by czarist restrictions from the schools of higher learning in Russia, he attended the University of Ghent, Belgium, where he received, in 1911, the degree of Docteur en sciences physiques et mathématiques. Coming to this country in that year, he taught successively at three universities before joining the faculty of the University of Oklahoma in 1916. His *College Geometry* (1925) added a new subject to the mathematical curriculum of our American colleges and was translated into Chinese. As a sequel to this book he published, in 1935, his *Modern Pure Solid Geometry*.

Blackstone Studios

ZAY JEFFRIES, B.S. in Mining Engineering, Metallurgical Engineer, Sc.D., D.E., has just become Vice President of the General Electric Company and Manager of the Chemical Department, moving up from his previous position as Technical Director of the Lamp Department. As he is another man of great achievement we cannot do justice to his career in this column. He was born at Willow Lake, South Dakota, in 1888 and was educated at the South Dakota School of Mines and at Harvard. Until 1917 he taught at the Case School of Applied Science and then went into industrial research on aluminum. As consultant he became associated with the National Lamp Works of General Electric in 1914. He was elected to the National Academy of Sciences in 1939. He is the co-author of several technical books, the recipient of a number of medal awards, and a member of numerous technical societies and organizations. At present he serves as Vice-Chairman of the War Metallurgy Committee of the National Research Council. He holds and has held many other important offices.

A MICA MINE
IN A LABORATORY

War shortages crop up in strange materials. Mica, for instance. Once seen principally in the windows of stoves, and in small boys' pockets, it is now used extensively as electrical insulation. In some war products, it is virtually indispensable: capacitors for radio, spark-plugs for airplane engines, insulators in electronic tubes.

With demand mounting, manufacturers were desperate. A four-man technical mission flew to London to help ration the world's supply between the United States and Great Britain. The shortage was serious.

The War Production Board, convinced that much mica was classified too low when judged by appearance alone, asked Bell Telephone Laboratories to develop a new method of electrical tests. The Laboratories were able to do this quickly because of their basic knowledge and experience in this field.

The new tests were made available to manufacturers in this country and abroad—the supply of usable mica was increased 60%—and a difficult situation relieved.

Skill to do this and other war jobs is at hand in Bell Laboratories because, year after year, the Laboratories have been at work for the Bell System.

BELL TELEPHONE LABORATORIES *Exploring and inventing, devising and perfecting for our Armed Forces at war and for continued improvements and economies in telephone service.*

THE SCIENTIFIC MONTHLY

Vol. LX, No. 2 **FEBRUARY, 1945** **Whole No. 353**

An illustrated magazine broadly interpreting to the thoughtful public the progress of science and its relations to the problems confronting civilization. Published by the American Association for the Advancement of Science, Smithsonian Institution Building, Washington 25, D. C.

Edited by F. L. Campbell.

Advertising Manager: Theo. J. Christensen.

Editorial Advisers: John E. Flynn, D. R. Hooker, Kirtley F. Mather, and William J. Robbins.

Contributing Editors: William A. Albrecht, Arthur Bevan, L. V. Domm, Wilton M. Krogman, B. S. Meyer, Frank H. H. Roberts, Jr., Malcolm H. Soule, Edward J. Stieglitz, Harlan T. Stetson, and H. B. Tukey.

Address all correspondence concerning editorial matters and advertising to the Office of The Scientific Monthly, Smithsonian Institution Building, Washington 25, D. C.

Office of publication, North Queen St. and McGovern Avenue (The Science Press Printing Co.), Lancaster, Pa.

Subscriptions: The calendar year, $5.00; single numbers, 50 cents.

Orders for subscriptions and requests for changes of address should be directed to the Office of the Permanent Secretary of the Association, Smithsonian Institution Building, Washington 25, D. C. Two weeks are required to effect changes of address.

Copyright, 1945, by the American Association for the Advancement of Science.

Entered as second-class matter at the post office at Lancaster, Pa., U. S. A. July 18, 1923, under the Act of March 3, 1879.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Founding and Organization

IN 1848, on September 20, the Association was formally organized and held its first meeting; in 1874 it was incorporated under the laws of the Commonwealth of Massachusetts and given the right to receive, purchase, hold and convey property. Its governing body is a Council, now having 255 members.

The Association is national in scope, with membership open to the whole world on equal terms, and its interests include the broad fields of the natural and the social sciences. Its varied activities are carried on under 16 sections with which 189 affiliated and associated societies, having a combined membership of nearly a million, cooperate in organizing programs for its meetings.

Members and Meetings

All persons engaged in scientific work, all who find pleasure in following scientific discoveries, all who believe that through the natural and social sciences a better society may be achieved are eligible for membership in the Association. From its founding, the most distinguished of American scientists, including every American Nobel Laureate in science and every president of the National Academy of Sciences, have been members. The names of many university presidents, of eminent scholars in widely different fields, and of men notable for public service, including a United States Senator, a Justice of the Supreme Court, and a former president of the United States, are now on its roll of more than 27,000 members.

The Association's meetings are field days of science attended by thousands of participants at which hundreds of scientists vie with one another for the pleasure and the honor of presenting results of researches of the greatest benefit to their fellow men. An enlightened daily press reports their proceedings throughout the country.

Opportunity and Responsibility

A world torn by conflicts and fearful of the future is looking more and more toward scientists for leadership. The opportunity for unparalleled service is theirs and the fact that they have available the only essentially new methods, if not purposes, imposes an equal responsibility. For these reasons it will be the Association's steadfast purpose to promote closer relations among the natural and the social scientists, and between all scientists and other persons with similar aspirations, to the end that they together may discover means of attaining an orderliness in human relations comparable to that which they find in the natural world about them.

MEET THE AUTHORS

T. A. Boyd, B.Ch.E. and C.E., is the Head of the Fuel Department, General Motors Research Laboratories Division. During the years since 1923 he has worked in close association with Dr. Charles F. Kettering, and from the experiences of those years he presents an accurate picture of Dr. Kettering's manifold achievements. Like Dr. Kettering, "Tab" Boyd was born in Ohio and received his education at The Ohio State University. After graduating in 1918 he joined the staff of the Dayton Metal Products Company as a research chemist. In 1920 both the company and Mr. Boyd were absorbed by the General Motors Corporation. Engine fuels, first automobile and later aircraft, have been the chief focus of Mr. Boyd's research. He is the author of two books and sixteen technical papers and has published thirty-two papers jointly with other scientists.

E. W. Gudger, Ph.D., has contributed many articles to The Scientific Monthly, and future generations may well think that the name Gudger was synonymous with the magazine. For more information see the April 1944 number.

William T. Shaw, B.Agr., M.S., Ph.D., has recently completed forty-two years of almost continuous teaching in zoology and related sciences in the Pacific Coast institutions of Oregon State, Washington State, Stanford University, the University of Redlands, and Fresno State. Dr. Shaw was born in 1873 at Woodburn, Ontario. He received his bachelor's degree from Minnesota, his master's from Michigan State, and his doctor's from Stanford. For many years Dr. Shaw has spent his summers in studying problems of life history and ecology among the faunal forms of the Sub-Arctic zones on the mountains of Washington State and of Saskatchewan. Fondness for biological exploration culminated in the supervision and taxidermy involved in developing the Central California Habitat Groups.

A dazzling achievement
in electronics
simply and clearly explained

SEEING
THE
INVISIBLE

The Story of the
Electron Microscope

by

GESSNER G. HAWLEY

Describes in non-technical language what the electron microscope is, how it works, how it was developed, and what it has so far accomplished, particularly in the fields of medical and industrial research. The author discusses the instrument's limitations and what is expected of it in the future. With more than 70 illustrations, including many remarkable photographs taken under the electron microscope. The author is Technical Editor of the Reinhold Publishing Corporation.

At all bookshops $2.50

This is a

BORZOI BOOK

published in New York by

ALFRED A. KNOPF

DAGOBERT D. RUNES, Editor

TWENTIETH CENTURY PHILOSOPHY

Unique and invaluable is this collection of 22 Essays written by the great contemporary philosophers on current world-wide topics. Each page is alive . . . vital to intelligent opinion today!

CONTRIBUTORS INCLUDE:

JOHN DEWEY	ROSCOE POUND
BERTRAND RUSSELL	JACQUES MARITAIN
A. N. WHITEHEAD	WING-TSIT CHAN
GEORGE SANTAYANA	JOHN ELOF BOODIN
WM. P. MONTAGUE	D. C. MACINTOSH

PARTIAL CONTENTS

- Philosophy of Life
- Materialism of the U.S.S.R.
- Philosophy of Science
- Theology
- American Realism
- Philosophy of China
- Naturalism
- Philosophy of Law
- Metaphysics
- Humanism

Extensive Bibliography follows each Selection

571 Pages Cloth Bound $5.00

THE PHILOSOPHICAL LIBRARY, INC.

MAIL THIS COUPON NOW

PHILOSOPHICAL LIBRARY, Inc.
15 E. 40th St., Dept. D, New York 16, N. Y.

Please send me ..... copies of TWENTIETH CENTURY PHILOSOPHY, at $5.00 each. I enclose payment of $.....

Name .....

Address .....

MEET THE AUTHORS, Continued

WILLIAM T. SKILLING, M.S., Emeritus Professor of Astronomy at the San Diego State [Teachers] College, is another former contributor to THE SCIENTIFIC MONTHLY. Many will recall his article, "Whence the Heat of the Sun and Stars?" published in the February 1944 issue. That same issue also carries his biographical sketch.

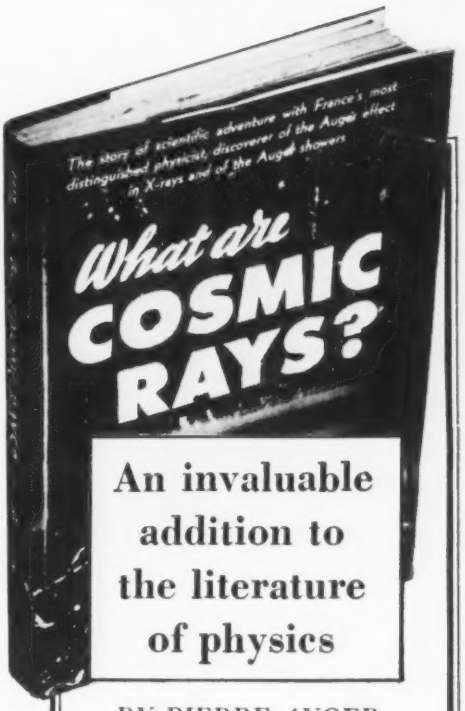
JAMES E. COLLIER, M.A., is presently serving as Instructor in Geography at the University of Missouri. Born in Todd County, Kentucky, in 1913, he attended Western Kentucky Teachers College and took two years of graduate work at the University of Cincinnati. At the latter institution he served as a graduate assistant in the Department of Geology and Geography. From 1938 to 1941 during the summer seasons he worked as a guide at the famous Mammouth Cave National Park. As a result of his many trips through the cave, he was called upon to write descriptions of the features to be seen on the various routes in the cave. These descriptions are now incorporated in a pamphlet prepared for visitors. Besides teaching geography, Mr. Collier is now working on a study of the economic-geographic aspects of the aluminum industry.

HARRY GRUNDFEST, PH.D., is the National Secretary of the American Association of Scientific Workers. He was born in Minsk, Russia, in 1904 and came to the United States in 1913 because the laws of Czarist Russia restricted the education of Jews. Following undergraduate and graduate work in the Laboratory of Biophysics of Columbia, Dr. Grundfest was a National Research Council Fellow at Columbia and the University of Pennsylvania and neurophysiologist at Cornell Medical College and Rockefeller Institute for Medical Research. He has been on leave of absence from the Institute since June 1943 to serve as Senior Physiologist at Fort Monmouth Signal Laboratory.

MEET THE AUTHORS, Continued

MICHAEL POLANYI, M.D., PH.D., has been Professor of Physical Chemistry at Victoria University, Manchester, England, since 1933. Born in Budapest, Hungary, he received his university training in that city and Karlsruhe, Germany. He was studying at Karlsruhe when World War I broke out, and he was called into service in the Austro-Hungarian army; but not before he had completed a number of scientific papers on thermodynamics and laying the foundations for his theory of adsorption, which is now generally accepted throughout the world. During World War I he was a medical officer for four years. In December of 1919 he was forced out of the University of Budapest by the Horthy regime and returned to Karlsruhe. In 1923 he was appointed Privatdozent at the Technische Hochschule in Berlin and in the same year was made a member of the Kaiser Wilhelm Institut für Physikalische Chemie. In 1933 he resigned a life membership (made in 1929) in the Kaiser Wilhelm Institute as a protest against the anti-Jewish legislation being enacted by the Hitler regime. A fortnight later he was invited to a chair in Manchester and has been there since. In 1943 further recognition came to Dr. Polanyi when he was elected a Fellow of the Royal Society. He has two sons, one of whom is serving in the British Army. His publications include: "Atomic Reactions" (1932), "U.S.S.R. Economics" (1935), "Money and Unemployment" [a diagrammatic film] (1939), and "The Contempt of Freedom" (1940). German and British scientific journals have published his articles dealing with plasticity, adsorption, crystal structure, and chemical reaction kinetics. American readers will find interesting his article "The English and the Continent" published in *Fortune* for May 1944. [Wartime mail difficulties have interfered with our attempts to secure a recent picture of Dr. Polanyi. ED.]

JOHN J. DAVIS, B.S., doubles in brass as Head of the Department of Entomology and Chief in Entomology in the Agricultural Experiment Station at Purdue University. Born in Illinois in 1885, he studied at the University of Illinois from 1903–7. From the University he went to the U. S. Department of Agriculture Laboratories at Lafayette, Indiana, and stayed there until he was appointed Professor of Entomology at Purdue in 1920. Among the high positions that he has held are: Vice-president (1935) and President (1938) of the Association of Economic Entomologists; Governor of the Crop Protection Institute (1934–39); Editor (1922–28) and President (1931) of the Indiana Academy of Science; and Treasurer and Editor of the Thomas Say Foundation.


The story of scientific adventure with France's most distinguished physicist, discoverer of the Auger effect in X-rays and of the Auger showers
What are COSMIC RAYS?

An invaluable addition to the literature of physics

BY PIERRE AUGER

A comprehensive, authoritative, and accurate explanation of one of the most important discoveries of modern physics.

France's most distinguished physicist, discoverer of the Auger effect in X-rays and of the Auger showers, traces the story of cosmic rays since their discovery . . . A story of adventurous research, in the laboratory and at the ends of the earth, that has opened new worlds to the minds and skills of man.

ARTHUR H. COMPTON (Winner of the Nobel Prize for Physics, 1927): "The best book that has yet appeared for . . . the educated scientific public without technical knowledge of physics, and physicists who want a quick view of this new field of specialization."

Illustrated with many photographs of cosmic-ray cloud-chamber tracks. *$2.00*

UNIVERSITY OF CHICAGO PRESS

5750 Ellis Ave., Chicago 37, Ill.

NEW BOOKS*

Consider the Calendar. BHOLA D. PANTH. 138 pp. Illus. 1944. $1.25. Teachers College, Columbia University, New York.

Agitation for a change of the English system of measurements and of the Gregorian Calendar have gone on in this country for many years with prospects for reform no closer than the enfranchisement of the citizens of the District of Columbia. This paper-covered book presents a good review of the history of calendars and of proposals for modern improvements.

What Are Cosmic Rays? PIERRE AUGER. 128 pp. Illus. 1945. $2.00. The University of Chicago Press, Chicago.

A broad, up-to-date discussion of all the major cosmic-ray phenomena written primarily for lay readers. Non-mathematical in approach, it describes with clarity the modern instruments and techniques that enable the physicist to detect subatomic particles. From the discovery of cosmic rays the book moves swiftly down through time to the use of stratospheric balloon flights for data verification.

Seeing the Invisible. GESSNER G. HAWLEY. 195 pp. Illus. 1945. $2.50. Alfred A. Knopf, New York.

Another most readable book, written so that the layman can understand a major research tool of the scientist. Scientists from other fields, as well as laymen, will be able to understand the importance of what has been accomplished with the electron microscope in the few years of its existence and to grasp both the vast potentialities and the limitations of its use in the future.

Pioneering the Helicopter. C. L. MORRIS. 160 pp. Illus. 1945. $2.75. McGraw-Hill Book Company, New York and London.

The *whys* and *how* of "Sikorsky's Nightmare" that makes all of us potential pilots. An intimate record of all the first failures and later successes in the development of the airplane that is making history by standing still. Written by Sikorsky's Chief Test Pilot, the lucid explanations with accompanying sketches and in-flight photographs make the helicopter a vivid reality.

Freud, Master and Friend. HANNS SACHS. 195 pp. Illus. 1944. $2.50. Harvard University Press, Cambridge, Mass.

A personal and subjective account about the Viennese professor by an ardent disciple and associate. Not intended as a full biography or a discussion of Freud's development of psychoanalysis as a psychiatric tool, it presents intimate pictures of the professor's life and relations with his co-workers. The sharp conflicts which came between Jung, Adler, Stekel, Rank, and Freud are described, and an attempt is made to evaluate the contribution of each.

Education for Responsible Living. WALLACE B. DONHAM. 309 pp. 1944. $3.00. The Harvard University Press, Cambridge, Mass.

A frank demand for a new pattern in general education by the former Dean of Harvard's Graduate School of Business Administration. Rejecting what he considers radical solutions now in use at Chicago, St. John's, Antioch and Bennington, the author outlines a definite program for a new curriculum based on reforming the Liberal Arts College.

Birds of the Southwest Pacific. ERNST MAYR. 316 pp. Illus. 1945. $3.75. The Macmillan Company, New York.

A book of color plates, line drawings, and excellent wordpictures of the hitherto little-known bird fauna that live in the Southwest reaches of the Pacific. A book to be kept at hand when reading letters from service men in that theatre of the war. Divided into two sections, the book is easy to use and packed with many data gathered during the 17 years the author studied the ornithology of the region.

* Orders for the books noticed above should not be sent to THE SCIENTIFIC MONTHLY or the A.A.A.S., but to your bookseller or the publisher.

SCIENCE offers A New Advertising Service

Many subscribers of THE SCIENTIFIC MONTHLY know and read regularly the companion publication of the A.A.A.S., SCIENCE, The Weekly Newsmagazine of the Scientific World. Because of this we want to acquaint the readers of THE SCIENTIFIC MONTHLY with a new advertising service that will make its debut in the February 2, 1945 issue of SCIENCE. Beginning in that issue classified advertising will appear in a column titled "In The Market Place" and an appropriate cut will be used at the head to help readers find it.

The purpose of this new service is to assist the members of the A.A.A.S. and other readers of SCIENCE and THE SCIENTIFIC MONTHLY to buy, sell or exchange equipment, supplies and other scientific items. At the present time there is a great need for all types of equipment and in many laboratories there is much equipment that is little used. "In The Market Place" will be a medium whereby these needs can be made known and a sale or loan arranged to mutual advantage.

Notices of employment opportunities and situations wanted will be accepted. The Column should likewise be helpful to those seeking back numbers of books and journals of the various scientific societies.

Rates for insertions will be 10¢ a word with a minimum charge of $2.00. If a box address is desired include 8 words to cover. All charges are to be paid in advance and no discounts are allowed. Copy should be in our office four weeks in advance of publication. Address Advertising Department, The American Association for the Advancement of Science, Smithsonian Institution Building, Washington 25, D. C.

Ready in April

An excellently illustrated text which gives the new concepts while not neglecting previous achievements

Principles of Physical Geology

By ARTHUR HOLMES, *D.Sc., F.R.S.,*
Regius Professor of Geology and Mineralogy, University of Edinburgh

INTRODUCES a method of treatment which twenty years' experience has shown to be successful in training students and holding their interest even when some of them come to the subject with little preliminary acquaintance with scientific principles and methods. The arrangement is planned to bring out the relationship of each aspect of the subject to the whole, so that its significance can be properly grasped and appreciated. This elementary book successfully incorporates the interesting results achieved by recent progress with many of the spectacular discoveries made possible by modern methods of investigation. At the frontiers of established knowledge current interpretative views are introduced, showing the student the active growth of the subject, but also indicating to him that a number of topics necessarily are controversial because the guiding facts are still too few to provide a foundation for more than tentative hypotheses.

Scope of Contents

A PRELIMINARY SURVEY
The Shape and Surface Relief of the Earth
The Changing Face of the Earth
Materials of the Earth's Crust: Minerals
Material of the Earth's Crust: Common Rocks.
Architectural Features of the Earth's Crust
Rocks as the Pages of Earth History
EXTERNAL PROCESSES AND THEIR EFFECTS
Rock Weathering and Soils
Underground Waters
River Action and Valley Development
Development of River Systems and Associated Landforms
Glaciers and Glaciation
Wind Action and Desert Landscapes
Coastal Scenery and the Work of the Sea
Life as a Rock Builder
Life as a Fuel Maker: Coal and Oil
INTERNAL PROCESSES AND THEIR EFFECTS
Earthquakes
Earth Movements: Mountain Building
Earth Movements: Plateaus and Rift Valleys
Volcanic Activity
Continental Drift
Index

Illustrations—the illustrations, which are distinctive and excellent, are made an important feature. Over 200 of the figures have been specially drawn for the book, and striking and instructive photographs have been contributed by authorities in Britain, America and other countries.

640 Pages **357 Illustrations** **Price $4.00**

The Ronald Press Company Publishers
15 East 26th Street • • • New York 10

THE SCIENTIFIC MONTHLY

Vol. LX, No. 3 MARCH, 1945 Whole No. 354

An illustrated magazine broadly interpreting to the thoughtful public the progress of science and its relations to the problems confronting civilization. Published by the American Association for the Advancement of Science, Smithsonian Institution Building, Washington 25, D. C.

Edited by F. L. Campbell.

Advertising Manager: Theo. J. Christensen.

Editorial Advisers: John E. Flynn, D. R. Hooker, Kirtley F. Mather, and William J. Robbins.

Contributing Editors: William A. Albrecht, Arthur Bevan, L. V. Domm, Wilton M. Krogman, B. S. Meyer, Frank H. H. Roberts, Jr., Malcolm H. Soule, Edward J. Stieglitz, Harlan T. Stetson, and H. B. Tukey.

Address all correspondence concerning editorial matters and advertising to the Office of The Scientific Monthly, Smithsonian Institution Building, Washington 25, D. C.

Office of publication, North Queen St. and McGovern Avenue (The Science Press Printing Co.), Lancaster, Pa.

Subscriptions: The calendar year, $5.00; single numbers, 50 cents.

Orders for subscriptions and requests for changes of address should be directed to the Office of the Permanent Secretary of the Association, Smithsonian Institution Building, Washington 25, D. C. Two weeks are required to effect changes of address.

Copyright, 1945, by the American Association for the Advancement of Science.

Entered as second-class matter at the post office at Lancaster, Pa., U. S. A. July 18, 1923, under the Act of March 3, 1879.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Founding and Organization

IN 1848, on September 20, the Association was formally organized and held its first meeting; in 1874 it was incorporated under the laws of the Commonwealth of Massachusetts and given the right to receive, purchase, hold and convey property. Its governing body is a Council, now having 255 members.

The Association is national in scope, with membership open to the whole world on equal terms, and its interests include the broad fields of the natural and the social sciences. Its varied activities are carried on under 16 sections with which 189 affiliated and associated societies, having a combined membership of nearly a million, cooperate in organizing programs for its meetings.

Members and Meetings

All persons engaged in scientific work, all who find pleasure in following scientific discoveries, all who believe that through the natural and social sciences a better society may be achieved are eligible for membership in the Association. From its founding, the most distinguished of American scientists, including every American Nobel Laureate in science and every president of the National Academy of Sciences, have been members. The names of many university presidents, of eminent scholars in widely different fields, and of men notable for public service, including a United States Senator, a Justice of the Supreme Court, and a former president of the United States, are now on its roll of more than 27,000 members.

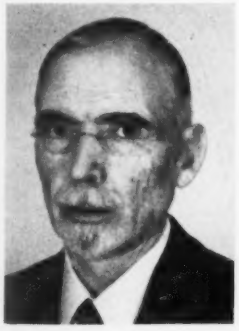
The Association's meetings are field days of science attended by thousands of participants at which hundreds of scientists vie with one another for the pleasure and the honor of presenting results of researches of the greatest benefit to their fellow men. An enlightened daily press reports their proceedings throughout the country.

Opportunity and Responsibility

A world torn by conflicts and fearful of the future is looking more and more toward scientists for leadership. The opportunity for unparalleled service is theirs and the fact that they have available the only essentially new methods, if not purposes, imposes an equal responsibility. For these reasons it will be the Association's steadfast purpose to promote closer relations among the natural and the social scientists, and between all scientists and other persons with similar aspirations, to the end that they together may discover means of attaining an orderliness in human relations comparable to that which they find in the natural world about them.

MEET THE AUTHORS

A. G. KELLER, Ph.D., Emeritus Professor of the Science of Society in Yale, was born in Springfield, Ohio, in 1874. Contrary to the advice of Horace Greeley to young men to go west, he went east to Connecticut when he was 12 years of age. As might be expected, he took his university work at Yale, receiving his A.B. degree in 1896 and his Ph.D. in 1899. Immediately after receiving his doctorate he was appointed an instructor in Yale College, and an assistant professor in 1902. In 1907 he was given the unusual title of Professor of the Science of Society, later the William Graham Sumner professorship under the same title. Among his many books are *Societal Evolution, Industry and Trade, Through War to Peace, Evolution of Man, Science of Society, Man's Rough Road*, and several volumes of essays, including *Earth Hunger and Other Essays*, and *The Forgotten Man and Other Essays*. He has two daughters, one of whom is a director of nursing, and a son, who is now a captain in the U. S. Army, and three grandchildren.



FRANCIS B. SUMNER, Professor of Biology in the Scripps Institution of Oceanography of the University of California, a member of the A.A.A.S. since 1902, a member of the National Academy of Sciences, and a contributor to THE SCIENTIFIC MONTHLY, off and on, for 25 years, finds it amusing to be "met" by the readers of this magazine. He was born in Connecticut in 1874, spent his childhood in California, took his high school work in Colorado Springs, received his B.S. degree in Minnesota in 1894, and returned east to Columbia from which he received the Ph.D. degree in 1901. His whole life has been spent in teaching and studying zoology on or by the sea. He was at the Naples Zoological Station in 1899, 1900, and 1910; Director of the Biological Laboratories of the Bureau of Fisheries, Woods Hole, Mass., from 1903 to 1911, and Naturalist on the *Albatross* during its voyages in 1912, 1913.

THE AMERICAN SCHOLAR

A Quarterly for the Independent Thinker

published by

PHI BETA KAPPA

$2.50—1 yr., $4.50—2 yrs., $6.00—3 yrs.

PHI BETA KAPPA, founded "to recognize and encourage scholarship, friendship, and cultural interests," is America's oldest honorary society. Election by the local chapters is based primarily on the broad cultural interests and scholarly achievements of the students whose work has been definitely liberal in character and purpose. Membership fees, set at a minimum of $2 to be paid at the time of election, vary among the chapters, now 142 in number. All members receive THE KEY REPORTER, the Society's membership quarterly.

HIRAM HAYDN, *Secretary*

12 East 44th Street, New York 17, N. Y.

GENETICS SOCIETY OF AMERICA

Organized in 1932 to provide facilities for association and conference among students of heredity and for the encouragement of close fellowship between workers in genetics and those in the related sciences.

All persons actively interested in any field of genetics are eligible to membership. Dues are $2.00 per year, of which 50¢ goes towards the maintenance of *Biological Abstracts* and 50¢ towards the maintenance of the journal *Genetics*.

The *Records of the Genetics Society of America* is published annually, and contains abstracts of the papers to be presented at the annual meeting.

•

DR. LAURENCE H. SNYDER,
Secretary-Treasurer
Dept. of Zoology and Entomology,
The Ohio State University,
Columbus 10, Ohio

*NEW BOOKS**

The Psychology of Invention in the Mathematical Field. JACQUES HADAMARD. 143 pp. 1945. $2.00. Princeton University Press, Princeton, N. J.

This pocket-size book tackles an encylopedic subject and does it well. The problem of controlling the mechanism of thinking is outlined with clarity, and logical working methods applicable not only to mathematics but to all fields of science are integrated into the entire text.

Tempo and Mode in Evolution. GEORGE GAYLORD SIMPSON. 237 pp. Illus. 1944. $3.50. Columbia University Press, New York.

Here is a *new* approach to the mysteries of evolution that might well be titled the "living story of the dead." To explain the development of present-day forms of life, data from genetics and paleontology (two seeming diverse fields) are synthesized. The results justify both the labor already expended and encouragement for still more research on this subject.

An Introduction to Electronics. RALPH G. HUDSON. 97 pp. Illus. 1945. $3.00. The Macmillan Company, New York.

Scientists as well as laymen have been encouraged to expect many wonders from electronics in the postwar period. This short book, written with a minimum use of technical words and well illustrated with diagrams and plates, helps to get electronics out of the realm of theory and into the land of understanding by practical people. It is to be read for fundamental principles and to stimulate one to think about applications to his own field.

Edward Bellamy. ARTHUR E. MORGAN. 468 pp. Illus. 1944. $5.00. Columbia University Press, New York.

Antioch College's Arthur E. Morgan undertook this biography of Edward Bellamy after his career as administrator of TVA. Based on a careful analysis of many papers hitherto undisclosed, the author of *Looking Backward*—which had a profound influence on American thought during the last half of the nineteenth century—is revealed as the source of many modern socio-economic theories.

The Hopi Way. LAURA THOMPSON and ALICE JOSEPH. 151 pp. Illus. 1945. $3.00. The University of Chicago Press.

This book is a thought-provoking exposition of the cultural and social customs of the Hopi Indians, by which they have preserved their way of life in a setting that has all but obliterated the distinctive cultural patterns of other Indian tribes in the U. S. Traditionally known as the "Peaceful People," the Hopi have lived a democracy that holds many lessons for latter-day Americans.

Climate of Indiana. S. S. VISHER. 511 pp. Illus. 1944. Indiana University, Bloomington, Indiana.

This comprehensive climatological analysis is based on years of study over the entire State of Indiana. Supported by accurate data in large quantities, it can be read with profit both for applications to nearby areas and as a method and pattern for study of the climatology of other regions.

Crime and the Human Mind. DAVID ABRAHAMSEN. 244 pp. 1944. $3.00. Columbia University Press, New York.

The author, a Norwegian M.D., presents a practical and useful volume for attacking the twin problems of how to detect aberrations of the human mind that lead to criminality and what the treatment should be when such tendencies are discovered. The text is well documented with references to recent research in the fields of psychiatry and psychology.

* Orders for the books noticed above should not be sent to THE SCIENTIFIC MONTHLY or the A.A.A.S., but to your bookseller or the publisher.

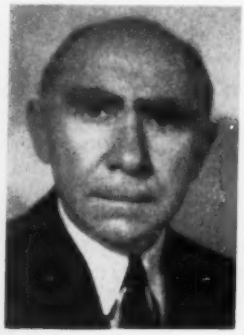
MEET THE AUTHORS, Continued

EDWARD H. DAVIS, son of a retired sea captain, who owned and sailed merchant vessels on the seven seas, was born in Brooklyn in 1862. At 22 he went to San Diego, California, for his health, making the journey by sea and across the Isthmus of Panama by train. In 1887 he acquired a ranch in Mesa Grande, northeast of San Diego, on which he has since lived. For more than 60 years he has been a neighbor of the Mission Indians of Southern California, and during that period he has observed the Diegeños and Luisaños and others in their transition on Government Reservations to the ways of white men. Early in his contact with them, becoming interested in their former habits and culture, he began to make extensive notes on their customs and legends and to take photographs of them and their dwellings. From 1920, on for 20 years, he was a collector for the Museum of the American Indians of New York, and during this period visited regularly the Seri Indians and many other tribes of Southern California and Northwestern Mexico.

E. YALE DAWSON was not born in New Haven, Conn., but in Creston, in southern Iowa, in 1918. From boyhood his foremost interest was natural history, though he grew up and was educated in a period after biological science had been divided and subdivided into many fields. His college work was done at the University of California, from which he received the Ph.D. degree in 1942. Beginning in 1933 he made numerous botanical excursions into Mexico and in 1940 he was botanist with the Allan Hancock Expedition to the Gulf of California. While investigating algae along the Sonora Coast, in Mexico, he came in contact with the Seri Indians and became a friend of Mr. Davis. Soon after receiving his Ph.D. degree, he was inducted into the Army, first commissioned in the Corps of Engineers and now in the Army Air Forces, but doing research for the U. S. Navy in La Jolla, Calif.

MEET THE AUTHORS, Continued

DON L. IRWIN, a pioneer all his life, was born on a farm near Wellington, Kansas, in 1888. His memory reaches back to the time when corn was burned for fuel during the nineties. His education through the three R's was acquired in the rural schools of Kansas; his secondary school work, in the Winfield, Kansas, High School; his four years of college work, in Kansas State Agricultural and Mechanical College and in the Minnesota Agricultural College. He grew up on the prairies of Kansas, toughened in body, mind, and moral fiber. When Kansas became too crowded, he made a shift of well toward a thousand miles to the Big Horn Basin of Wyoming where he successfully owned and operated ranches for 18 years. Under orders of his neighbors he served in the Wyoming State Legislature for four years without being corrupted. Then he was sent to Washington to assist in plans for the Matanuska Colonization Project. Being crowded in Washington, he listened again to the call of the wild and went to Alaska.



WILLIAM A. HILTON, Ph.D., is Director of the Laguna Marine Laboratory in southern California and was Head of the Department of Zoology in Pomona College from 1912 until his retirement from teaching in 1944. His trips for obtaining biological specimens for his laboratory and college have taken him to the shores of every continent, twice in southern seas and twice into Arctic ice. "In the beginning" for Dr. Hilton means that he was born in Van Ettan, N. Y., in 1878. After graduating at Cornell in 1899 he continued as a fellow and received his Ph.D. degree in 1902. From that time on, when he was not roaming the wide, wide world, he spent most of his time in southern California, except for a year at Minnesota and as an exchange professor at Cornell. At odd times he wrote a few books and many papers and gathered up such mementoes as Phi Beta Kappa and Sigma Xi keys on the way.

THE SULLIVANT MOSS SOCIETY

The Sullivant Moss Society, established in 1898, has two annual meetings. The business session and the presentation of papers occur in connection with the A.A.A.S. winter meetings. The foray is held sometime during the summer. Membership in the Society entitles one to membership in the Hepatic and Moss Exchange Clubs. The Society has three herbaria: Moss Herbarium in Duke University, Hepatic Herbarium in University of Cincinnati, and Lichen Herbarium in Missouri Botanical Garden.

The Bryologist, published quarterly and now in its forty-eighth volume, is devoted to the study of North American mosses, hepatics, and lichens. Membership or subscription in the United States is $2.50 per year, net; in all other countries, $2.65 (in U. S. dollars or equivalent).

WINONA H. WELCH, *Secretary-Treasurer*
DePauw University
Greencastle, Indiana

The Ecological Society of America

Purpose: "The object of the Society shall be the promotion of the interests of ecology."

Members: *Associate*, $1.00, receive BULLETIN; *Contributing*, $2.00–$10.00, receive BULLETIN and may designate use of the donation; *Active*, $5.00, receive BULLETIN and ECOLOGY; *Sustaining*, $10.00, receive BULLETIN, ECOLOGY and ECOLOGICAL MONOGRAPHS; *Life*, single fee, $100, same as Active; *Sustaining Life*, single fee, $200, same as Sustaining.

Publications: The BULLETIN OF E.S.A. is a quarterly announcement of society business and programs of meetings with abstracts of the papers presented. ECOLOGY and ECOLOGICAL MONOGRAPHS are quarterly journals "devoted to all phases of ecological biology."

Information: Application blanks and other information about membership may be obtained from the Secretary, DR. WILLIAM A. DREYER, Department of Zoology, University of Cincinnati, Cincinnati 21, Ohio.

THE TORREY BOTANICAL CLUB

Affiliated with the N. Y. Academy of Sciences and with A.A.A.S.

Annual Membership dues $5.00 cover subscriptions to the two regular publications of the Club.

The Bulletin of the Torrey Botanical Club, bi-monthly, now in its 72nd volume.

Torreya, quarterly, now in its 45th volume.

Associate Membership dues **$2.00.**

Associate members are notified of all science meetings and field trips of the Club but do not receive its magazines.

Corresponding Secretary:

Dr. Jennie L. S. Simpson,

Hunter College,
695 Park Ave.,
New York 21, N. Y.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

The Academy is organized to promote and advance the science and art of medicine pertaining to the eye, ear, nose and throat through scientific meetings and instructional programs.

Physicians certified by the American Boards of Ophthalmology, Otolaryngology, or Plastic Surgery, who are members in good standing of their local, county, state and/or national medical societies, are eligible for Fellowship. Entrance fee is $20.00 and yearly dues, $10.00. Present membership is 3,700.

The TRANSACTIONS of the Academy, containing papers read at the annual meetings, are published bi-monthly.

W. L. Benedict, M.D.

Executive Secretary-Treasurer
100 First Avenue Building
Rochester, Minnesota

MEET THE AUTHORS, Continued

PAUL LAMARTINE YATES, now on loan from the British Ministry of Agriculture to the United Nations Interim Commission on Food and Agriculture, in Washington, began his adventures in this world in an old Queen Anne manor-house at Merton, Surrey, in 1908. Even during his school years he traveled widely in Europe and South Africa, experiences that contributed to his preparation for his present duties. After taking honor examinations, known as triposes, at Cambridge University, in history and economics, he studied at Berlin, Geneva, and elsewhere in Europe. On returning to England he became secretary to the Astor-Rountree Agricultural Group for three years during which he prepared the most comprehensive survey of British agriculture that had ever been written. Then he was sent on an extensive tour of farming regions throughout Western Europe. These investigations led him to write a book on food production in Western Europe and on the general problem of food and farming in Europe after the close of this war.

HAROLD L. DORWART, Associate Professor of Mathematics in Washington and Jefferson College, Washington, Pa., was born in Greenville, Pa., in 1902. After graduating from Washington and Jefferson College in 1924, he went to Yale from which he received the Ph.D. degree in 1931, serving during his residence in New Haven as an instructor in mathematics for four years. He regards mathematics not only as an important tool for many other disciplines but as a way of thinking, reasoning, and organizing knowledge.

RAYMOND E. JANSSEN'S article on "Pickle Helicites" earned him a niche in the May, 1944, issue.

JOEL W. HEDGPETH'S biographical sketch first appeared in the November, 1944, issue of SM. We recommend its rereading if for no other reason than to see a man-sized beard.

Physics students at Haverford College, using two L&N Resistance Boxes and an L&N Adjustable Mica Capacitor.

Resistance Boxes For Student Use

Haverford College physics students have for many years used these and other L&N laboratory instruments to conduct their experiments. The equipment shown above, a simple a-c bridge network to determine the characteristics of a capacitor, has withstood hard student use for almost 14 years—and still maintains its initial accuracy and shows little signs of wear. Four L&N instruments are used in this measurement: two resistance boxes (a 3-dial and 4-dial box), an Adjustable Mica Capacitor. A telephone is employed as a balance detector.

Both resistance boxes have enclosed switches, and can be used in d-c or low frequency a-c measurements. Resistors are mounted in rotary-switch 5-coil decades, each of which provides a zero position and nine steps of resistance change. Limit of error in the resistance boxes is $\pm (0.1\% + 0.01 \text{ ohm})$.

Our No. 1058 Adjustable Mica Capacitor is direct reading, with a total capacitance of 1 microfarad in five sections: 0.5, 0.2, 0.2, 0.05, 0.05 μf.

L&N laboratory instruments are so constructed that the student can easily remove the top plate, to which the internal parts are attached, and study the bus-bar wiring of the instruments.

We'll be glad to send Broadside E, listing the complete line of L&N instruments for research, teaching, and testing.

Jrl Ad EB43(2a)

depends on me!
A Slogan For Every American

LEEDS & NORTHRUP COMPANY, 4945 STENTON AVE., PHILA. 44, PA.
LEEDS & NORTHRUP
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

THE SCIENTIFIC MONTHLY

Vol. LX, No. 4 APRIL, 1945 Whole No. 355

An illustrated magazine broadly interpreting to the thoughtful public the progress of science and its relations to the problems confronting civilization. Published by the American Association for the Advancement of Science, Smithsonian Institution Building, Washington 25, D. C.

Edited by F. L. Campbell.

Advertising Manager: Theo. J. Christensen.

Editorial Advisers: John E. Flynn, D. R. Hooker, Kirtley F. Mather, and William J. Robbins.

Contributing Editors: William A. Albrecht, Arthur Bevan, L. V. Domm, Wilton M. Krogman, B. S. Meyer, Frank H. H. Roberts, Jr., Malcolm H. Soule, Edward J. Stieglitz, Harlan T. Stetson, and H. B. Tukey.

Address all correspondence concerning editorial matters and advertising to the Office of The Scientific Monthly, Smithsonian Institution Building, Washington 25, D. C.

Office of publication, North Queen St. and McGovern Avenue (The Science Press Printing Co.), Lancaster, Pa.

Subscriptions: The calendar year, $5.00; single numbers, 50 cents.

Orders for subscriptions and requests for changes of address should be directed to the Office of the Permanent Secretary of the Association, Smithsonian Institution Building, Washington 25, D. C. Two weeks are required to effect changes of address.

Copyright, 1945, by the American Association for the Advancement of Science.

Entered as second-class matter at the post office at Lancaster, Pa., U. S. A. July 18, 1923, under the Act of March 3, 1879.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Founding and Organization

IN 1848, on September 20, the Association was formally organized and held its first meeting; in 1874 it was incorporated under the laws of the Commonwealth of Massachusetts and given the right to receive, purchase, hold and convey property. Its governing body is a Council, now having 255 members.

The Association is national in scope, with membership open to the whole world on equal terms, and its interests include the broad fields of the natural and the social sciences. Its varied activities are carried on under 16 sections with which 189 affiliated and associated societies, having a combined membership of nearly a million, cooperate in organizing programs for its meetings.

Members and Meetings

All persons engaged in scientific work, all who find pleasure in following scientific discoveries, all who believe that through the natural and social sciences a better society may be achieved are eligible for membership in the Association. From its founding, the most distinguished of American scientists, including every American Nobel Laureate in science and every president of the National Academy of Sciences, have been members. The names of many university presidents, of eminent scholars in widely different fields, and of men notable for public service, including a United States Senator, a Justice of the Supreme Court, and a former president of the United States, are now on its roll of more than 27,000 members.

The Association's meetings are field days of science attended by thousands of participants at which hundreds of scientists vie with one another for the pleasure and the honor of presenting results of researches of the greatest benefit to their fellow men. An enlightened daily press reports their proceedings throughout the country.

Opportunity and Responsibility

A world torn by conflicts and fearful of the future is looking more and more toward scientists for leadership. The opportunity for unparalleled service is theirs and the fact that they have available the only essentially new methods, if not purposes, imposes an equal responsibility. For these reasons it will be the Association's steadfast purpose to promote closer relations among the natural and the social scientists, and between all scientists and other persons with similar aspirations, to the end that they together may discover means of attaining an orderliness in human relations comparable to that which they find in the natural world about them.

MEET THE AUTHORS

CHAUNCEY D. LEAKE, vice president of the University of Texas Medical Branch, in Galveston, Texas, was born in Elizabeth, N. J., in 1896. During World War I he was a student at Princeton from which he received his first college degree in 1917. After duty with the Chemical Warfare Service until the close of the war he migrated to Wisconsin, where he received the M.S. degree in 1920 and the Ph. D. degree in 1925. While at Wisconsin, he was, first, Instructor of Physiology (1920–23), then Assistant Professor of Pharmacology (1923–25), and Associate Professor (1925–28). Early in his academic career he became deeply interested in philosophy, especially while studying at Princeton under Edwin G. Conklin, Norman Kemp Smith, and Warner Fite. He was called to the University of California Medical Center, San Francisco, in 1928, where he organized its Pharmacological Laboratory. In 1940 he was instrumental in establishing at Berkeley a course on Human Relations. Now this indomitable optimist is formulating ethical principles by the methods of science.

FORREST H. KIRKPATRICK, one of the officers of the Radio Corporation of America in charge of personnel administration and labor relations, was born in Northern Ohio, completed his secondary school work in Western Ohio, and then went to Bethany College, West Virginia, from which he received his A.B. degree, an institution to which he later returned for several years as Dean of Students and Professor of Personnel Administration. Part of his graduate work was at Columbia, from which he received the A.M. degree in 1931, and the remainder was at the University of London. He gave several courses at Butler University and New York University. With the progress of the war he became a special consultant for the War Manpower Commission (1942–43) and a Consultant on Personnel Administration for the Department of State in 1944.

Up-to-Date-Books

—•—

Warships of the World

Edited by KAFKA and PEPPERBURG

Greatest naval encyclopedia ever published! Fully describes 52 world navies. Stories of 900 warships in World War II from official sources.

"A book for long-time reference . . . an eye-opener for the land-bound, and for all those seeking a knowledge of all phases of this most complicated war."—*Field Artillery Journal.*

Should be "in the country's schools, colleges, high school and grammar school libraries."—Comdr. Walter Karig, USNR (co-author of *Battle Report*).

1,051 Pages 900 Illustrations $15.00

Diving, Cutting and Welding in Underwater Salvage Operations

By FRANK E. THOMPSON, JR.

The only book of its kind—indispensable for anyone connected with salvage: civilian, Army and Navy engineers; trainers, trainees; salvage companies, individuals who repair their own boats.

"An expert on salvage . . . provides an excellent compendium on shallow and deep water diving procedure and equipment, handling of accidents and injuries, methods of salvage, and underwater cutting and welding."—U. S. Naval Institute *Proceedings.*

224 Pages $2.00

Meteorology for Ship and Aircraft Operation

By PETER E. KRAGHT

Senior Meteorologist, American Airlines, Inc.

This is a carefully developed book, especially designed to meet the needs of navigators. It is thorough and comprehensive, authoritative in presentation and practical in viewpoint. Will prove as invaluable to the student navigator as to the experienced aviator, mariner, or teacher.

"Answers the demand for a sound textbook on meteorology . . . a thorough study of this important subject without ponderous complex formulae." — *Aero Digest.*

373 Pages Illustrated Tables $3.00

Meteorology Workbook with Problems

By PETER E. KRAGHT

"The author covers the subject of basic meteorology in a most realistic manner. His many illustrations are not merely supplementary to the text, but make a pictorial foundation for an understanding of weather as related to flying, sailing, and other activities. Too much praise cannot be given him for his problems which demonstrate to the student the relationship between pure and applied meteorology more clearly than many more advanced textbooks."—E. M. Brooks, *Bulletin of the American Meteorological Association.*

148 Pages, 141 illustrations, 8 sample weather maps, photographs of cloud formations, indexed, $2.25

At Your Bookseller or Direct

CORNELL MARITIME PRESS

241 West 23rd Street Dept. SM New York 11, N.Y.

NEW BOOKS*

The Future of Industrial Research. Standard Oil Development Company. 173 pp. 1945. Limited edition.

A volume bringing together the papers and discussions presented at the meeting celebrating the twenty-fifth anniversary of the establishment of the Research Division of Standard Oil Development Company. In part, a review of past events; its more important parts are those sections by leading research executives as they look toward the future.

Thomas Jefferson's Garden Book. Annotated by EDWIN MORRIS BETTS. 704 pp. Illus. 1944. $5.00. The American Philosophical Society, Philadelphia, Pa.

T. Jefferson—The most ubiquitous intellectual of all Presidents is presented in a new facet—that of chronicler of Nature on his Monticello estate. The title "Garden Book" is Jefferson's own, but many other of his interests crop out. Jefferson bids fair to be a rival of Abraham Lincoln as the "most-written-about-President" and this volume weighs heavily on Jefferson's side.

Telescopes and Accessories. GEORGE Z. DIMITROFF and JAMES G. BAKER. 309 pp. Illus. 1945. $2.50. The Blakiston Company, Philadelphia, Pa.

What are telescopes, why and how do they work and what can man learn about his surrounding cosmos of infinity through their use are some of the questions this book answers for the neophyte and amateur astronomer. The schematic diagrams—extremely useful to non-technical readers—are plentiful and understandable.

Practical Marine Navigation. JAMES A. STOWELL. 133 pp. Illus. 1945. Addison-Wesley Press, Inc., Cambridge, Mass.

"How not to be at sea, at sea" might well have been the sub-title of this handbook for beginners interested in sailing. A glossary up front instead of at the back is one of its good features. Proven methods of navigation are explained in correct nautical language so that the newcomer gets the quarterdeck feeling immediately.

Theory of X-Ray Diffraction in Crystals. W. H. ZACHARIASEN. 249 pp. 1945. $4.00. John Wiley and Sons, Inc., New York.

A technical presentation of the theory of x-ray diffraction applied to ideal and real crystal structures. New theories and extensions of presently accepted ones are dealt with; experimental techniques are treated to a lesser degree.

Fundamentals of Physics. HENRY SEMAT. 593 pp. Illus. 1945. $4.00. Farrar and Rinehart, Inc., New York.

Each new text-book in a field should focus attention on more recent applications and give the instructor an opportunity to reexamine his own teaching materials and methods. Dr. Semat's book should be read for both of these reasons.

* Orders for the books noticed above should not be sent to THE SCIENTIFIC MONTHLY or the A.A.A.S., but to your bookseller or the publisher.

MEET THE AUTHORS, Continued

RALPH W. PHILLIPS, Senior Animal Husbandman in charge of Genetics Investigations in the Bureau of Animal Industry of the U. S. Department of Agriculture, was born in Parsons, West Virginia, in 1909. He received the B.S. degree from Berea College in 1930, A.M. from Missouri in 1931, and Ph.D. from Missouri, in 1934. For three years he was assistant in animal industry in Missouri, then an instructor in Massachusetts State College for three years (1933–36), after which he went to the Bureau of Animal Industry in the U. S. Department of Agriculture for three years. His published scientific papers deal with results of researches on various phases of the physiology of reproduction, with special reference to inheritance of important traits in livestock. For fourteen months in 1943–44 he was a consultant on animal breeding to the Governments of China and India under the auspices of the U. S. Department of State.

JOHN A. SHELLENBERGER, a chemist and Professor of Milling Industry at Kansas State College, was born at Moline, Illinois, in 1900. His education was interrupted by a term of service in the Tank Corps in World War I. For his undergraduate work he went to Seattle, receiving the B.S. degree from Washington in 1928. Then he migrated to Kansas State College which gave him the M.S. in 1930, and thence to Minnesota for the Ph.D. in 1935. In the interval, however, he had served as chemist for a flouring mill in Seattle, an assistant professor and agricultural chemist in Idaho, and an instructor in Minnesota. After receiving his doctorate, he became chief biochemist for the Rohm and Haas Co., and more recently agricultural consultant for the Armour Research Foundation which led to his serving as technical adviser to the *Corporación para la promoción del Intercambio,* a position that took him to South America for two years during which he traveled approximately 25,000 miles in Argentina.

MEET THE AUTHORS, Continued

C. WYTHE COOKE, Senior Geologist of the U. S. Geological Survey, was born in Baltimore in 1887. He did his college preparatory work at Randolph-Macon Academy, Front Royal, Va., and at Baltimore City College. He took his college and graduate work at The Johns Hopkins University (A.B., 1908; Ph.D., 1912), where he held a University Fellowship and was elected to Phi Beta Kappa. While still a student he was appointed Junior Geologist on the U. S. Geological Survey, with which he has been connected since his original appointment. His field work in this country has been chiefly in the Atlantic and Gulf Coastal Plain States, but he has also made geological investigations in the Dominican Republic, Colombia, British Honduras, and Guatemala. His published reports of Southeastern United States contain original geological maps of more than 125,000 square miles. Since 1937 he has been the editor of the *Journal of Paleontology*.

H. H. REMMERS, Professor of Education and Director of the Division of Educational Reference in Purdue since 1931, was born in Norden, Germany, near the Dutch border, in 1892. In his childhood his family came to America, settling on a farm in southwestern Iowa. He received his A.B. degree from Iowa in 1921, the A.M. in 1922, and the Ph.D. in 1927. In 1922–23 he was an instructor in psychology and education, and he has been summer lecturer at Iowa, California, and Washington, and continuously on the staff of Purdue since 1923. He has published numerous (about 200) technical papers and monographs. His latest book (with N. L. Gage) is "Educational Measurement and Evaluation," the first in a series on "Education for Living," of which he is editor for Harper and Brothers. He has come to realize that the human animal is as much *homo patiens* as *homo sapiens*, and this realization has influenced his choice of work. For 6 years he was Secretary of the A.A.A.S. Section on Education and he is now a vice president.

Manufacturer Wants INVENTIONS

INVENTORS—The Lion Manufacturing Corporation of Chicago, a highly rated concern, employing 1,400 is interested in inventions for their plant and affiliated companies. Our interest is in patented or patentable electrical or mechanical devices for post-war development in the following fields: Radio and Television, Sound and Recording, Household Appliances, Vending Machines, Coin Operated Amusement Devices, in fact almost anything of metal or plastic. We invite inventors to send us details concerning their patented inventions. If your invention is not patented, tell us in a general way what you have to offer. If we are interested, we shall inform you how to communicate details without endangering your rights.

LION MANUFACTURING CORPORATION
Department 7
135 S. La Salle Street, Chicago 3, Illinois

THE GEOLOGICAL SOCIETY OF AMERICA

The Geological Society of America was organized 57 years ago for "the promotion of the science of geology in North America." Through the bequest of Dr. R. A. F. Penrose, Jr., received in 1932, the Society is now recognized as "the great geological foundation." All phases of geologic science are recognized, represented and supported with grants-in-aid of research and publication, and the Society cooperates with all special national geological societies, established geological agencies of government and international geological organizations. Membership is by invitation and election; is based upon scientific contribution. Initiation and annual dues are $10.

Publications include the Bulletin carrying five to seven papers per monthly issue, with photographic plates, text figures and folded charts and maps (some in color). The Special Papers, largely in paleontology, too long for either the Bulletin or the Journal of Paleontology, are issued occasionally. The Memoirs are longer papers also; areal monographs of wider reader interest or treatises on special techniques. The Bibliography and Index of Geologic Literature exclusive of North America is issued annually (biennial during war years), and complements the North American Index of the United States Geological Survey.

All publications are available to the public on subscription or on a cash basis at cost. Current issues carry lists of all publications with prices, and orders are promptly filled.

HENRY R. ALDRICH, Secretary
419 West 117 Street, New York 27, N. Y.

THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS was organized in 1889 and the first volume of its official organ, the Journal of Economic Entomology, was published 1908. Prior to that time, reports of the meetings were included in publications of the old Division of Entomology of the U. S. Department of Agriculture.

The Association is organized to promote the study, and advance the science of entomology, and to publish the *Journal of Economic Entomology* and other entomological works. To date, six volumes of the *Bibliography of Economic Entomology* have been published, based on five year intervals. As a result of the joint summer meeting at Durham, New Hampshire, a symposium, *Chemical Control of Insects*, was published by the A.A.A.S. *The Common Names of Insects* is also printed at intervals by the American Association of Economic Entomologists.

The Association has a membership of approximately 1,650 and a subscription list of about 2,500, of which 2,200 are on this continent and the balance in nearly every country of the world.

Subject matter sections in Apiculture, Plant Pest Control and Quarantine, Extension, Teaching and Industrial Entomology have been approved. Three regional branches hold annual conferences and several independent entomological organizations are affiliated.

ERNEST N. CORY
Secretary-Treasurer and Business Manager
College Park, Md.

THE AMERICAN DIETETIC ASSOCIATION

Object: To improve the nutritional status of human beings; to bring about closer cooperation among dietitians and nutritionists and workers in allied fields; to raise the standard of dietary work.

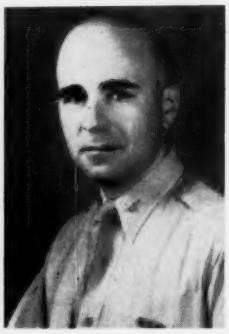
Membership: Individual; 7,000 professionally qualified dietitions employed in hospitals, college, school and industrial food service, restaurants, public health agencies and other institutions.

Publications: Journal, monthly, $3.00.

•

GLADYS E. HALL,
Executive Secretary
620 North Michigan Avenue
Chicago 11, Illinois

MEET THE AUTHORS, Continued



JACOB CHAITKIN, attorney from New York City and since September, 1942, in the American armed forces, was born on the shores of the Baltic, in Russia. During his childhood he attended a governmental school of the type of the Real-Gymnasium, and spoke Russian and German with equal fluency. His college and law degrees were received from the University of Pittsburgh. For twenty years he practiced law in New York City. During several years preceding the war he specialized in litigation against the North German Lloyd Line and other German corporate debtors. Having command of both English and Russian, he translated many fine examples of Russian literature into English, which were published in such magazines as *The Freeman, Poet Lore, Golden Book*, and *Encore* magazine. He has taught Russian in the Pentagon Building; more recently in California Institute of Technology, and had an article, "Russian is So Easy to Learn," in the November, 1943, *Esquire*.

V. S. SWAMINATHAN, author of the article "Scientific and Industrial Research" in this issue of THE SCIENTIFIC MONTHLY, is a native of India and graduated from Madras University in Natural Science. For a short time he was a Lecturer in Geology in Presidency College, also in Madras, a city of over 600,000 population in southeastern India on the Bay of Bengal. He was a Medallist of the Mining and Geological Institute of India, Calcutta, and Sir William Meyer Student for Post-graduate Research in Economics and Urban Geography at London University. He is the author of several papers on geology and geography which he has presented before the Indian Science Congress and the British Association for the Advancement of Science. He is now making a study of planned economic development in Britain and of demographic and land utilization problems in Europe.

EDWARD H. DAVIS and E. YALE DAWSON were pictured and publicized on page iv of the March issue of THE SCIENTIFIC MONTHLY, in which the first part of their article on "The Savage Seris of Sonora" appeared. They continue their discussion of what ultimately happens to those who choose to wage total war.

Northwestern physics professor demonstrates milliammeter calibration with an L&N Students' Potentiometer.

Students' Potentiometer FOR MANY POTENTIAL MEASUREMENTS

Physics students can of course assemble their own potentiometers, but Northwestern Technological Institute feels that the degree of accuracy of such "home-made" instruments and the amount of knowledge gained through assembling them does not warrant the time spent on this project.

So Northwestern has purchased L&N Students' Potentiometers, and classes now devote more time to exploring the many uses of potentiometers as laboratory tools. The superior accuracy of the "Students'" commands the respect of its users and gives them a more practical idea of just how closely they can work with even a comparatively inexpensive potentiometer, such as this one.

Actually, students get a better knowledge of the make-up of a potentiometer from this "Students'" than if they had assembled their own instruments. By simply removing the top plate, they can study not only *how* the instrument is assembled, but how it *should* be assembled—for L&N potentiometers are the work of expert instrument makers. With the range for potential measurement from thermocouple temperatures through pH measurements and meter calibration, students still become familiar with the potentiometer circuit, for they must connect all accessories, such as keys, switches, galvanometer, standard cell, etc.

Jrl Ad EH(5b)

depends on me!
A Slogan For Every American

LEEDS & NORTHRUP COMPANY, 4945 STENTON AVE., PHILA. 44, PA.
LEEDS & NORTHRUP
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

THE SCIENTIFIC MONTHLY

Vol. LX, No. 5 **May, 1945** **Whole No. 356**

An illustrated magazine broadly interpreting to the thoughtful public the progress of science and its relations to the problems confronting civilization. Published by the American Association for the Advancement of Science, Smithsonian Institution Building, Washington 25, D. C.

Edited by F. L. Campbell.

Advertising Manager: Theo. J. Christensen.

Editorial Advisers: John E. Flynn, D. R. Hooker, Kirtley F. Mather, and William J. Robbins.

Contributing Editors: William A. Albrecht, Arthur Bevan, L. V. Domm, Wilton M. Krogman, B. S. Meyer, Frank H. H. Roberts, Jr., Malcolm H. Soule, Edward J. Stieglitz, Harlan T. Stetson, and H. B. Tukey.

Address all correspondence concerning editorial matters and advertising to the Office of The Scientific Monthly, Smithsonian Institution Building, Washington 25, D. C.

Office of publication, North Queen St. and McGovern Avenue (The Science Press Printing Co.), Lancaster, Pa.

Subscriptions: The calendar year, $5.00; single numbers, 50 cents.

Orders for subscriptions and requests for changes of address should be directed to the Office of the Permanent Secretary of the Association, Smithsonian Institution Building, Washington 25, D. C. Two weeks are required to effect changes of address.

Copyright, 1945, by the American Association for the Advancement of Science.

Entered as second-class matter at the post office at Lancaster, Pa., U. S. A. July 18, 1923, under the Act of March 3, 1879.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Founding and Organization

In 1848, on September 20, the Association was formally organized and held its first meeting; in 1874 it was incorporated under the laws of the Commonwealth of Massachusetts and given the right to receive, purchase, hold and convey property. Its governing body is a Council, now having 255 members.

The Association is national in scope, with membership open to the whole world on equal terms, and its interests include the broad fields of the natural and the social sciences. Its varied activities are carried on under 16 sections with which 189 affiliated and associated societies, having a combined membership of nearly a million, cooperate in organizing programs for its meetings.

Members and Meetings

All persons engaged in scientified work, all who find pleasure in following scientific discoveries, all who believe that through the natural and social sciences a better society may be achieved are eligible for membership in the Association. From its founding, the most distinguished of American scientists, including every American Nobel Laureate in science and every president of the National Academy of Sciences, have been members. The names of many university presidents, of eminent scholars in widely different fields, and of men notable for public service, including a United States Senator, a Justice of the Supreme Court, and a former president of the United States, are now on its roll of more than 27,000 members.

The Association's meetings are field days of science attended by thousands of participants at which hundreds of scientists vie with one another for the pleasure and the honor of presenting results of researches of the greatest benefit to their fellow men. An enlightened daily press reports their proceedings throughout the country.

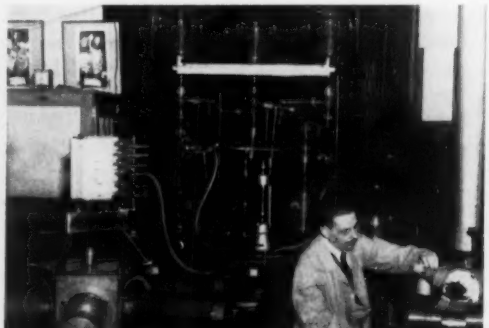
Opportunity and Responsibility

A world torn by conflicts and fearful of the future is looking more and more toward scientists for leadership. The opportunity for unparalleled service is theirs and the fact that they have available the only essentially new methods, if not purposes, imposes an equal responsibility. For these reasons it will be the Association's steadfast purpose to promote closer relations among the natural and the social scientists, and between all scientists and other persons with similar aspirations, to the end that they together may discover means of attaining an orderliness in human relations comparable to that which they find in the natural world about them.

MEET THE AUTHORS

KARL P. SCHMIDT is Chief Curator of Zoology at the Chicago Natural History Museum. Further biographical details are published on page iv of the November 1944 SCIENTIFIC MONTHLY.

WILLIAM FIRTH WELLS, Associate Professor of Research in Air-Borne Infection at the University of Pennsylvania School of Medicine since 1940, was born in Boston, Massachusetts, in 1887 and received the B.S. degree in biology and public health from the Massachusetts Institute of Technology in 1910. Prior to enlisting in the United States Army in 1917, Professor Wells held various positions in Washington, D.C., and in the University of Illinois. As an officer in the Sanitary Corps of the Army, Captain Wells served in France with the 301st Water Tank Train and was honorably discharged in 1918. After the close of the war he served on the State Conservation Commission of New York as a biologist and sanitarian for ten years. He took leave of absence during 1927–29 for work at the North Atlantic Oyster Farms where he developed the chlorination method of purifying oysters, and became the first to propagate artificially the oyster, quahaug, soft clam, and mussel. Professor Wells began his first years of work in sanitary ventilation and air-borne infection at Harvard University, where he became an instructor in sanitary science in 1930. In 1937, he went to the University of Pennsylvania, where the testing of his theory under field conditions was begun and has been continued. Professor Wells is proud to have been a pupil and disciple of William Thompson Sedgwick, the great American pioneer in sanitary science.



DR. HENRY PRATT FAIRCHILD, *Editor*

DICTIONARY of SOCIOLOGY

THE SOCIAL structure of the world is of primary importance today. All who are interested in human relations will find this work of great value: *social workers, statesmen, students, lawyers, teachers, librarians, research workers, guidance counsellors, et al.*

• **TYPICAL OF THE NEARLY 3,600 ENTRIES** •

geophagy. The practice of eating earth. Clay is eaten by numerous poverty-stricken people in the tenant farm areas of Alabama and Georgia as a food substitute, primarily to make up for dietary deficiencies.

ahimsa. The doctrine of nonviolence, as practised in India by Gandhi and his followers in their civil disobedience campaigns. The term includes all nonviolent forms of resistance, but excludes rioting, which often accompanies such campaigns.

"Represents a tremendous amount of work by a board of distinguished sociologists assisted by nearly 100 contributing editors. Will be consulted frequently and with profit."
—John A. Fitch, Columbia University

LIMITED EDITION ORDER NOW $6.00

PHILOSOPHICAL LIBRARY, Inc., *Publishers,*
15 E. 40th St., Dept. D, New York 16, N. Y.

Please send me .... copies of The Dictionary of Sociology, at $6.00 each. I enclose payment of $.....
NAME .....
ADDRESS .....

NEW BOOKS*

The Doctor's Job. CARL BINGER, M.D. 235 pp. 1945. $3.00. W. W. Norton and Co., Inc., New York.

Winner of the 1945 Norton Medical Award. A very readable book for physician and patient alike, dealing with many phases of their relationships. Its thesis is that *trained* human understanding is a basic requirement for successful treatment. A carefully thought-out chapter on socialized medicine and another on choosing a physician are two of the book's best features.

Discovery of the Elements. MARY ELVIRA WEEKS. 578 pp. Illus. 1945. $4.00. Journal of Chemical Education, Easton, Pa.

Enlarged and revised, this volume continues to serve a most useful function—that of bringing together in one place a detailed history of the chemical elements. Textbooks and works of reference must of necessity omit the interesting—and often exciting—records of the discovery of the elements. The voluminous bibliography after each chapter and the thorough research for facts evidenced by the completeness of the various subjects warrant continued use of this book by both scientists and laymen.

Microbial Antagonisms and Antibiotic Substances. SELMAN A. WAKSMAN. 337 pp. Illus. 1945. $3.75. The Commonwealth Fund, New York.

P. notatum and *P. chrysogenum*—known to the layman simply as Penicillin—have to a large extent stolen the spotlight from other antibiotic substances. In this book, one of the foremost researchers in the whole field brings the known antibiotic substances into the range of consideration and evaluates them. Research workers will find much use for an extensive bibliography of more than 1,000 references, excellent illustrations and complete review of the entire subject brought together in this one volume.

Aviation Radio. HENRY W. ROBERTS. 637 pp. Illus. 1945. $5.00. William Morrow and Co., New York.

The adaptation of modern radio communication—the link between aircraft in flight and earth that makes possible long distance flying and "instrument flying"—is expertly presented in this book written by the winner of the 1940 Harmon medal. The five main sections cover basic radio principles, primary and advanced radio facilities for aviation, radio navigation, and aviation radio apparatus. The profusion of photographs, cutaway and schematic drawings enables the reader to visualize each piece of aviation radio equipment and its function.

A Manual of Soil Fungi. JOSEPH C. GILMAN. 392 pp. Illus. 1945. $5.00. The Collegiate Press, Inc., Ames, Iowa.

This handbook illustrated with many line drawings is designed to place in the hands of microbiologists, plant pathologists, biochemists and physicians a reference work listing complete information about soil fungi encountered in their investigations. It is divided into four main sections, one devoted to each of the following: *Phycomycetes; Ascomycetes; Fungi Imperfecti;* and *Mycelia Sterilia.* An extensive bibliography and a glossary are contained in the appendix.

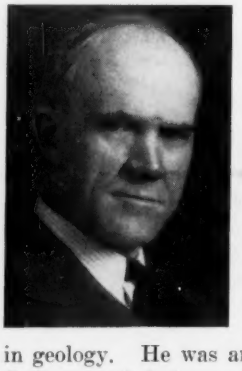
The Story of Penicillin. BORIS SOKOLOFF, M.D. 167 pp. 1945. $2.00. Ziff-Davis Publishing Co., Chicago.

Here is a pocket-sized volume intended for both layman and scientists giving the dramatic story of penicillin. With the first penicillin now being made available for general civilian use, this volume serves a useful purpose in explaining the abilities of the "wonder drug" to cure and also in pointing out its limitations. The story of Penicillin is also the story of chemotherapy, a field of cooperative research and practice among physicians, chemists, and bacteriologists; and Dr. Sokoloff gives an excellent account of the results of this cooperation.

* Orders for the books noticed above should not be sent to THE SCIENTIFIC MONTHLY or the A.A.A.S., but to your bookseller or the publisher.

MEET THE AUTHORS, Continued

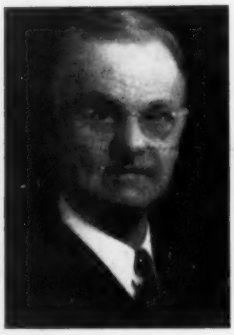
WILLIAM A. ALBRECHT, Professor of Soils and Chairman of the Department at the University of Missouri where he has been a member of the staff since 1916, was born on a farm in Central Illinois in 1888 and grew up with an intense interest in the soil and all things agricultural. He received his A.B., B.S., and Ph.D. (1919) from the University of Illinois. Dr. Albrecht's studies in soils have dealt with the functional viewpoint of the soil's service in nourishing all life. His research in nitrogen fixation has developed the technique of using colloidal clay as a nourishing medium for plants and as a means of bringing plant-soil relations under more careful control. His scientific contributions have emphasized the fundamental necessity of feeding plants, animals, and mankind through ministrations to the soil itself and correcting dietary deficiencies at their point of origin—in soils that have been found wanting.



GRIFFITH TAYLOR, Professor of Geography and Head of the Department at the University of Toronto, was born in London in 1880 and received his B.S., B.M.E., and Sc.D. (1916) from the University of Sydney, Australia. In 1910, he was awarded the A.B. degree from Cambridge University for research in geology. He was an instructor in geology at Sydney and lecturer in physiography at Melbourne before becoming Head of the Department of Geography at Sydney in 1920. Coming to the United States in 1929, Dr. Taylor taught geography at the University of Chicago until 1935, when he joined the staff of the University of Toronto. He has published 25 books dealing with various aspects of geography, the Antarctic, and anthropology. He was Senior Geologist in Captain Scott's Antarctic Expedition from 1910–13 and holds six medals for research. Dr. Taylor was President of the Geography Section of the British Association for the Advancement of Science in 1938 and President of the American Association of Geographers in 1941.

MEET THE AUTHORS, Continued

CARL B. BOYER, Assistant Professor of Mathematics at Brooklyn College, was born in 1906 at Hellertown, Pennsylvania, and attended the public schools of New York City. He attended Columbia College, graduating in 1928 with honors in mathematics and election to Phi Beta Kappa. After taking his Master's degree, he was inspired by Professor Frederick Barry to study the history of science, and in 1939 he received the doctorate in this field at Columbia University. Dr. Boyer's thesis on the historical development of the concepts of the calculus was published with the aid of a grant from the American Council of Learned Societies. He has taught mathematics at Brooklyn College since 1928, and since 1935 he has given lectures on the history of science at Rutgers University. A member of the Council of the History of Science Society and a Fellow of the A.A.A.S., Dr. Boyer has contributed historical papers to mathematical and scientific journals.



JAMES G. NEEDHAM, Emeritus Professor of Entomology at Cornell University, Ithaca, New York, was born on a farm in Illinois in 1868 and was brought up to be a farmer—but wasn't one. After completing high school he became a clerk in a general store, but finding it wasn't in him to be a merchant, he entered Knox College. At college he rustled local news for the city paper and dreamed of becoming a newspaper man. This was not to be, for Dr. Needham became a school teacher after graduation from Knox in 1891. He was a Goldwin Smith Fellow at Cornell in 1896 and received the Ph.D. in 1898. In 1907 Dr. Needham joined the staff at Cornell, where he first became "exposed to biological research, and took it—a mild case, but with relapses now and then ever since." Dr. Needham has studied Living Nature for many years and has found unending interest in her resources; and in sharing that pleasure with hundreds of capable and loyal pupils, who now carry on all over the earth, he has found happiness.

AMERICAN SOCIETY of PARASITOLOGISTS

For the association of workers in parasitology and for the advancement of parasitological teaching and investigation.

Any person interested in parasitology may apply for active membership.

The dues are four dollars per year, to cover subscription to the *Journal of Parasitology*, the official organ of the Society.

•

JAMES T. CULBERTSON, *Secretary*
Columbia University
New York 32, N. Y.

The National Education Association is the national professional organization for the teachers of the United States, corresponding to the American Bar Association for lawyers and the American Medical Association for physicians.

It was organized in Philadelphia in 1857 by 43 charter members. It now has over 300,000 members. It has three active memberships: *Regular*—$3; *Special*—$5; *Life*—$100. All active members receive the Journal of the National Education Association monthly during the school year. *Special* and *Life* Members receive, in addition to the Journal, the Research Bulletin, published quarterly, and the annual Volume of Addresses and Proceedings.

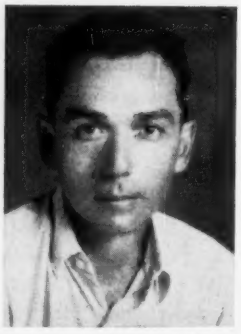
The Executive Secretary of the Association is Dr. WILLARD E. GIVENS, 1201 16th Street, N.W., Washington 6, D. C.

MEET THE AUTHORS, Continued

GEORGE C. VAILLANT, Director of the Museum of the University of Pennsylvania since 1941, was born in Boston, Massachusetts, in 1901. He received his A.B., M.A., and Ph.D. (1927) from Harvard University. Dr. Vaillant worked as a field assistant on various expeditions of the Peabody Museum, the Boston Museum of Fine Arts, and the Carnegie Institution in Southwestern United States, Maine, Egypt, British Sudan, Mexico, and Yucatan. He was assistant curator at the American Museum of Natural History from 1927–30 and associate curator from 1930–41. He has written monographs on technical aspects of Middle American archaeology and art and has published two books, *Indian Arts in North America* and *The Aztecs of Mexico*. Dr. Vaillant served as Cultural Relations Attaché at the American Embassy in Lima from March 1943 to July 1944 and has been associated in an advisory capacity on research and art with the American Council of Learned Societies, the State Department, and the Office of the Coordinator of Inter-American Affairs.

RAYMOND ADAMS, Professor of English at the University of North Carolina, was born in Elgin, Illinois, in 1898. He received his A.B. degree from Beloit College in 1920 and was a graduate fellow at the University of North Carolina from 1921–24, receiving his M.A. and Ph.D. in 1921 and 1928, respectively. He began to teach English at the University of North Carolina in 1924 and became Professor of English in 1939. President of the Thoreau Society since it was founded in 1941, Dr. Adams has written numerous articles about Thoreau, American transcendental literature, and liberal religion, including seven biographies for *The Dictionary of American Biography*. Since 1939 he has been compiler of "Research in Progress," an index of doctoral research in American literature which appears quarterly in the journal *American Literature*. His library of Thoreauana is the most extensive in existence.

MEET THE AUTHORS, Continued

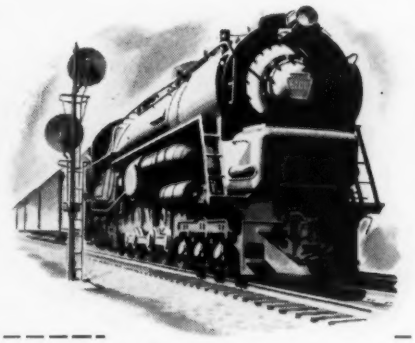


MARSTON BATES, a member of the International Health Division of the Rockefeller Foundation, lives in Villavicencio, Colombia, where he is now working on "jungle yellow fever." Born in Grand Rapids, Michigan, in 1906, but reared on a farm near Fort Lauderdale, Florida, Dr. Bates received his B.S. from the University of Florida in 1927, and the M.A. and Ph.D. from Harvard in 1933 and 1934. He started collecting butterflies at the age of 12, and attempts to break the habit have been unavailing. He first became interested in the biological problems of the tropical rain forest while working as an entomologist in Honduras and Guatemala from 1928 to 1931. After traveling in the Caribbean area on a Sheldon Fellowship during 1935, Dr. Bates joined the International Health Division, first working in Albania on the European mosquito *Anopheles maculipennis* until 1939, and then spending a year in Egypt. In late 1940 he moved to Villavicencio which he says is a marvellous place to work because it is possible to combine such diverse interests as rain forest ecology, the species problem, and animal behavior.

LANE W. LANCASTER, Professor of Political Science since 1930 and Chairman of the Department since 1939 at the University of Nebraska, was born in 1892 at Bellaire, Ohio. He received his A.B. in 1915 from Ohio Wesleyan, his A.M. in 1918 from the University of Illinois where he was University Scholar, and his Ph.D. in 1923 from the University of Pennsylvania where he was a Harrison Fellow. Before going to the University of Nebraska in 1930, Dr. Lancaster was assistant and associate professor in the Department of History and Government at Wesleyan University at Middletown, Connecticut, from 1923 to 1930. Besides contributing many articles and reviews to professional journals, Dr Lancaster has written two books, *State Supervision of Municipal Indebtedness* (1924) and *Government in Rural America* (1937). He is a member of the American Political Science Association.

In a bomber a GUNNER uses a new gun-sight lamp that permits him to aim *directly into the sun* — blasting enemy planes that otherwise would be invulnerable because of the blinding glare.

. . . the name on the GUNSIGHT LAMP is Westinghouse.

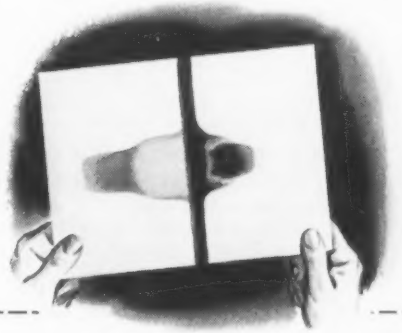


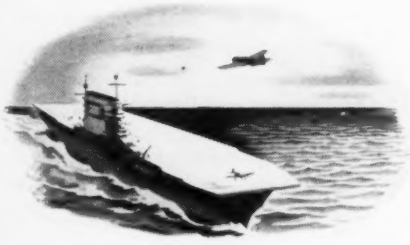
On a railroad an ENGINEER gets smoother operation — and 25% more power — from his steam locomotive because of a revolutionary new steam turbine drive.

. . . the name on the TURBINE DRIVE is Westinghouse.

In an Army arsenal a BALLISTICS EXPERT photographs projectiles, smashing through armor plate, with an x-ray tube that takes a picture in *1/1,000,000th of a second.*

. . . the name on the X-RAY TUBE is Westinghouse.





On a carrier a PLANE DIRECTOR uses a new kind of elevator to hoist planes on deck faster — keeping the deck cleared and getting fighters into the air quicker.

. . . the name on the ELEVATOR is Westinghouse.

Westinghouse

PLANTS IN 25 CITIES OFFICES EVERYWHERE

Tune in: JOHN CHARLES THOMAS
Sun. 2:30 pm, EWT, NBC

TODAY — Westinghouse skill in research and engineering is constantly at work, developing new and better war materials for final Victory.

TOMORROW — This same research and engineering skill will mean more dependable, more efficient industrial equipment and appliances for the home.

THE SCIENTIFIC MONTHLY

Vol. LX, No. 6 JUNE, 1945 Whole No. 357

An illustrated magazine broadly interpreting to the thoughtful public the progress of science and its relations to the problems confronting civilization. Published by the American Association for the Advancement of Science, Smithsonian Institution Building, Washington 25, D. C.

Edited by F. L. Campbell.

Advertising Manager: Theo. J. Christensen.

Editorial Advisers: John E. Flynn, D. R. Hooker, Kirtley F. Mather, and William J. Robbins.

Contributing Editors: William A. Albrecht, Arthur Bevan, L. V. Domm, Wilton M. Krogman, B. S. Meyer, Frank H. H. Roberts, Jr., Malcolm H. Soule, Edward J. Stieglitz, Harlan T. Stetson, and H. B. Tukey.

Address all correspondence concerning editorial matters and advertising to the Office of The Scientific Monthly, Smithsonian Institution Building, Washington 25, D. C.

Office of publication, North Queen St. and McGovern Avenue (The Science Press Printing Co.), Lancaster, Pa.

Subscriptions: The calendar year, $5.00; single numbers, 50 cents.

Orders for subscriptions and requests for changes of address should be directed to the Office of the Permanent Secretary of the Association, Smithsonian Institution Building, Washington 25, D. C. Two weeks are required to effect changes of address.

Copyright, 1945, by the American Association for the Advancement of Science.

Entered as second-class matter at the post office at Lancaster, Pa., U. S. A. July 18, 1923, under the Act of March 3, 1879.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Founding and Organization

In 1848, on September 20, the Association was formally organized and held its first meeting; in 1874 it was incorporated under the laws of the Commonwealth of Massachusetts and given the right to receive, purchase, hold and convey property. Its governing body is a Council, now having 255 members.

The Association is national in scope, with membership open to the whole world on equal terms, and its interests include the broad fields of the natural and the social sciences. Its varied activities are carried on under 16 sections with which 189 affiliated and associated societies, having a combined membership of nearly a million, cooperate in organizing programs for its meetings.

Members and Meetings

All persons engaged in scientified work, all who find pleasure in following scientific discoveries, all who believe that through the natural and social sciences a better society may be achieved are eligible for membership in the Association. From its founding, the most distinguished of American scientists, including every American Nobel Laureate in science and every president of the National Academy of Sciences, have been members. The names of many university presidents, of eminent scholars in widely different fields, and of men notable for public service, including a United States Senator, a Justice of the Supreme Court, and a former president of the United States, are now on its roll of more than 27,000 members.

The Association's meetings are field days of science attended by thousands of participants at which hundreds of scientists vie with one another for the pleasure and the honor of presenting results of researches of the greatest benefit to their fellow men. An enlightened daily press reports their proceedings throughout the country.

Opportunity and Responsibility

A world torn by conflicts and fearful of the future is looking more and more toward scientists for leadership. The opportunity for unparalleled service is theirs and the fact that they have available the only essentially new methods, if not purposes, imposes an equal responsibility. For these reasons it will be the Association's steadfast purpose to promote closer relations among the natural and the social scientists, and between all scientists and other persons with similar aspirations, to the end that they together may discover means of attaining an orderliness in human relations comparable to that which they find in the natural world about them.

MEET THE AUTHORS

E. C. HIGBEE, Senior Agronomist in the Office of Foreign Agricultural Relations, U. S. Department of Agriculture since 1944, was born in 1910 in the State of New York, but was reared in the Middle West. After receiving his M.A. in "Soils" from the University of Wisconsin in 1938, Mr. Higbee entered the employ of the Soil Conservation Service of the Department of Agriculture, remaining with that Service until 1941 when he became a member of the staff of the Office of Foreign Agricultural Relations. A special interest in tropical plants producing drugs and insecticides accounted for his Amazon assignments in 1942 and 1943. There he made an economic study of the trade in lonchocarpus roots, as well as numerous field explorations in search of higher rotenone-yielding plants. Mr. Higbee expects to leave in June for Guatemala, where he will serve as Senior Agronomist of the Agricultural Experiment Station. His hobby is collecting data on rural life and agricultural methods in the American Tropics.

A. K. LOBECK, Professor of Geology in Columbia University since 1929, was born in New York City in 1886, but grew up in the wilds of New Jersey. After graduating from Columbia University in 1911, he taught botany for several years before he learned that geology offered a better opportunity for travel and adventure. After receiving his Ph.D. from Columbia in 1917, he taught geology at Columbia (1916–18) and at the University of Wisconsin (1919–29). At the Paris Peace Conference in 1919 Professor Lobeck directed the work of some 25 cartographers; and in this war he finds an outlet for his cartographic interests as a consultant in the Topographic Branch of the Military Intelligence Service, War Department. He also lectures to naval officers on geomorphology and has organized several courses on photogrammetry for the U. S. Office of Education. Professor Lobeck's hobby is outdoor sketching and etching.

SCIENTIFIC and TECHNICAL Books

PHILOSOPHICAL LIBRARY INC. BOOKS PUBLISHERS

INTRODUCTORY ASTRONOMY
J. B. Sidgwick
Foreword by Dr. Clyde Fisher
"Of service to anyone who enjoys probing the mystery of the stellar universe. Includes 50 maps and glossary of terms."—*Science and Mechanics* **$2.50**

FROM COPERNICUS to EINSTEIN
Hans Reichenbach
"A captivating volume concerning space, time and motion—the essentials of astronomy. Explains relativity by simple experiments."
—*The New York Times* **$2.50**

PHYSICS of the 20TH CENTURY
Pascual Jordan
"In this brilliant work one of the leading contemporary physicists gives us his impression of the state of modern physics."—*Chicago Sun* **$4.00**

DICTIONARY of BIOCHEMISTRY
Prof. Wm. Marias Malisoff
"A new and interesting venture. Much care and thought have been expended on its compilation."
—*Nature* **$7.50**

DICTIONARY of SCIENCE and TECHNOLOGY
In English, French, German, Spanish
Maxim Newmark, Editor
"Separate indexes permit two-way references to all four languages. An eminently thorough, timely, practicable and useful book."
—*Prof. Harold Lenz, Queens College* **$6.00**

Illustrated TECHNICAL DICTIONARY
Maxim Newmark, Editor
"Based on the visual aid principle; an excellent reference work."—*Science and Mechanics*
"Useful, up-to-date, defines about 5,000 terms."
—*Library Journal* **$5.00**

Encyclopedia of SUBSTITUTES and SYNTHETICS
Morris D. Schoengold, Editor
"Anyone faced with the selection and use of materials should welcome this handy reference volume. The author has done particularly well."
—*General Electric Review* **$10.00**

Principles of POWDER METALLURGY
Franz Skaupy
A practical handbook written by one of the most eminent men in the field. "Subjects include the production of metal powders and ceramic-metal parts."
—*Aero Engineering Review* **$3.00**

At your bookstore, or order direct.

PHILOSOPHICAL LIBRARY Publishers
15 E. 40th St., Dept. D, N. Y. 16, N. Y.

Please send me ..... copies of the following books (write in margin).

Enclosed are $.....

NAME .....

ADDRESS .....

*NEW BOOKS**

The Shaping of Psychiatry by War. JOHN RAWLINGS REES, M.D. 158 pp. 1945. W. W. Norton and Co., Inc., New York.

The reflections of an English physician, veteran of two wars, on the practical applications of psychiatry to the problems of maintaining efficiency, mental health, and emotional stability of a large and complicated group of people living under the stress of modern warfare. The last part of the book points the way to capitalizing wartime experiences for the peacetime use of psychiatry.

A Source-book of Biological Names and Terms. EDMUND C. JAEGER. 256 pp. Illus. 1944. $3.50. Charles C Thomas, Springfield, Ill.

This is a compilation of thousands of word elements or combining forms from which scientific names are made. The origin of the parts with their original meanings are given, followed by examples to illustrate their use in the building of scientific terms. Students and scientists with nominal training in Latin and Greek should find it an excellent reference to have at hand.

The Dynamics of Culture Change. BRONISLAW MALINOWSKI. 171 pp. 1945. $2.50. Yale University Press, New Haven, Conn.

This posthumously published volume based on field researches in Africa examines the innumerable frictions arising from the White man's promise of a better world and his frequent failure, from the Native point of view, to provide it. The methodology developed for analysis of the African problems are applicable to other areas of friction, e.g., the United States, Europe, and the Orient.

Principles of Physical Geology. ARTHUR HOLMES. 640 pp. Illus. 1945. $4.00. The Ronald Press Company, New York.

Written by a foremost European geologist, the book is divided into three main sections. Part I undertakes a preliminary survey to lay a foundation for the more detailed work in the succeeding sections. Part II deals with the external processes working on the earth's surface and their effects. Part III examines the internal processes, such as earthquakes, volcanic activity, etc., and the results. Numerous illustrations, charts and diagrams from the work at large make it usable in every region.

The Builders of the Bridge. D. B. STEINMAN. 457 pp. Illus. 1945. $3.50. Harcourt, Brace and Company, New York.

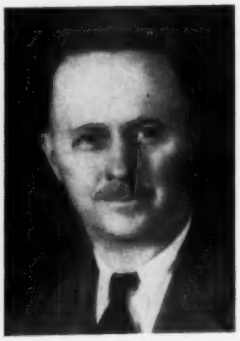
The Brooklyn Bridge is but one monument to the central figure of this biography. John Roebling, emigrant from Prussian tyranny, came to America for an opportunity to prove the practicality of the then-scorned suspension bridge. Years of patient research and finally his own development of wire rope gave the solution that sent spans across Niagara, the Ohio River, the Allegheny, and finally the Hudson.

The Pacific Islands Handbook, 1944. R. W. ROBSON, F.R.G.S. 371 pp. Illus. 1945. $4.00. The Macmillan Company, New York.

An up-to-the-minute American edition of an annual publication issued in Australia since 1932. The maps and text are based on the latest available data and in most instances from official sources. Among the topics included for each island group are: anthropology and history, populations, communications, industries (particularly the mineral industries), health (with statistics on the control of tropical diseases), and labor conditions. With the war emphasis shifting to the regions of the Orient and because of the increased role of the U. S. in the Pacific, it should have many uses by different people.

* Orders for the books noticed above should not be sent to THE SCIENTIFIC MONTHLY or the A.A.A.S., but to your bookseller or the publisher.

MEET THE AUTHORS, Continued



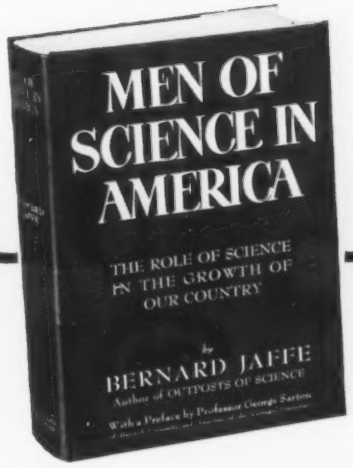
ALVAH PETERSON, Professor of Entomology in The Ohio State University since 1928, was born in 1888 at Galesburg, Illinois. He received his undergraduate education at Knox College (B.S., 1911) and his graduate training at the University of Illinois (Ph.D., 1916). Dr. Peterson was Associate Professor of Entomology at Rutgers College and Research Associate in Entomology at the N. J. Agricultural Experiment Station from 1916–25. He conducted biological control investigations on the oriental fruit moth for the U. S. Department of Agriculture at Moorestown, N. J. from 1925–28. Since coming to Ohio State in 1928, his work and investigations have been in the fields of biological control of insect pests and the identification of immature stages of insects. He has published two books and many articles in the fields of biological and applied entomology and hopes to publish an extensively illustrated book on insect larvae. Dr. Peterson is a member of the Entomological Society of America and the American Association of Economic Entomologists.

HERLUF H. STRANDSKOV, Assistant Professor of Zoology in the University of Chicago, was born November 4, 1898 in Lindsay, Nebraska. He received his education at Iowa State Teachers College (A.B., 1923), the University of Illinois (M.S., 1925), and the University of Chicago (Ph.D., 1931). Before going to Chicago in 1928, he was Assistant Professor of Biology at the University of Louisville. Dr. Strandskov's special research has been in the field of human genetics. He has published papers on A–B blood groups, the Rh blood factor, human plural birth frequencies, human sex ratios, human population problems, and inheritance of factors of intelligence. Dr. Strandskov is a member of American Society of Zoologists, American Naturalists, Genetics Society of America, American Statistical Association, Sigma Xi, and Stochastics. He likes to play chess and billiards.

MEET THE AUTHORS, Continued

FRANK G. BOUDREAU, Executive Director of the Milbank Memorial Fund since 1937, was born in 1886 in New Glasgow, Canada. After graduating in medicine at McGill University in 1910, he moved to Ohio, where he helped to organize a new public health system. From 1925–37 he was in the employ of the League of Nations at Geneva, where he served as statistician-epidemiologist, Director of the Health Organization, and Chief of Epidemiological Intelligence Service and Public Health Statistics. Since his return to the States he has been President of the League of Nations Association, Vice President of the Students International Union, a participant in the United Nations Conference on Food and Agriculture at Hot Springs, and adviser to the Director General of UNRRA at the first meeting of the Council in Atlantic City. Dr. Boudreau has traveled extensively in Europe, China, and South America, and now hopes to see more of the United States. His intense interest in nutrition is reflected by his chairmanship of the Food and Nutrition Board of the National Research Council and Technical Committee on Nutrition and Food Management of the United Nations Interim Commission on Food and Agriculture. He has a home in Greenwich Village and a retreat in the Catskills, which he hopes to visit more often after the war.

W. S. MAHLIE, Chemist in Charge of Water and Sewage Purification of the City of Fort Worth, Texas, was born in Bucyrus, Ohio, and graduated from Bucyrus High School in 1908. He was a special engineering student at The Ohio State University in 1916. Before taking his present position in Fort Worth in 1921, Mr. Mahlie was assistant chemist at the Water Purification Plant at Columbus, Ohio, from 1918–20. He is a member of the American Chemical Society and the American Water Works Association. He is co-author of *Manual for Water Works Operators* and has published 35 papers on water and sewage treatment.


MEN OF SCIENCE IN AMERICA
THE ROLE OF SCIENCE IN THE GROWTH OF OUR COUNTRY
by
BERNARD JAFFE
Author of OUTPOSTS OF SCIENCE
With a Preface by Professor George Sarton

"Ought to be read by scientist and non-scientist alike"

—The Scientific Monthly

"A series of lively personal sketches and a useful, rapid picture of what is going on in such fields as general physics, genetics, astronomy and atomic research." *—The New Republic*

"Mr. Jaffe gives us more than a series of penetrating biographies. We have not only pictures of exceptional scientists in action, but a history of science in biographical form. Though the men selected were not aware of their social importance, they influenced society profoundly. This social note vibrates through the book, and stands as an example of the way biographies should be written."

—Book-of-the-Month Club News

"A pioneer in an important field. Mr. Jaffe has succeeded in stating an outline of American science and in describing its continuities and interrelationships, and is, so far as I know, the first historian who has ever done so. He has written a book which has long been needed." *—New York Herald Tribune*

Professor George Sarton of Harvard has written the foreword. The book contains 600 pages, 28 plates, and 25 text diagrams. Third printing. Price $3.75

SIMON AND SCHUSTER, PUBLISHERS

*NEW BOOKS**

Science in Progress, 4th Series. Edited by GEORGE A. BAITSELL. 331 pp. Illus. 1945. $3.00. Yale University Press, New Haven, Conn.

This fourth volume of a series reports the latest developments in the nation's laboratories. Some have only recently been released from military security regulations. The reports are written by the chief investigators themselves and they describe research in pure science that is closely linked with the science of war and the art of living. All of the articles are significant because they tell of the work being done on the farthest frontiers of science. The book is sponsored by, and bears the imprimatur of the Society of Sigma Xi.

Freedom Is More Than a Word. MARSHALL FIELD. 190 pp. 1945. $2.50. University of Chicago Press.

The owner of the *Chicago Sun* and New York's *PM* writes a statement of his faith in the freedom of the press and radio. In the main it tells the story of the development of his two newspapers and his now historic battle with the Associated Press for a franchise in Chicago. As a statement of personal philosophy by a liberal devoting his huge personal fortune to the causes he believes in, it bears reading.

Science Year Book of 1945. Edited by JOHN D. RATCLIFF. 224 pp. 1945. $2.50. Doubleday, Doran and Company, New York.

This volume presents a collection of articles from current periodicals on the progress of science. Medicine, physics, chemistry, aviation, petroleum and electronics are only a few of the more important subjects included. The result is a panoramic picture of the swift pace of science in many directions and a glimpse of the distant horizons that will become solid ground under our feet in the approaching world of tomorrow.

When Democracy Builds. FRANK LLOYD WRIGHT. 131 pp. Illus. 1945. $4.00. University of Chicago Press.

From the pen of the architect of the now famous earthquake-proof Imperial Hotel in Tokyo, comes this provocative challenge for better planning of American homes and communities. He blueprints his arguments for decentralized cities with plans for a city of the future where an abundance of light, air and sunshine will combine with individual ownership. Going more deeply he attacks the socially undesirable results of haphazard urbanization and shows how judicious planning of homes and community buildings and services can overcome such mistakes.

The Male Hormone. PAUL DE KRUIF. 243 pp. 1945. $2.50. Harcourt, Brace and Company, New York.

The practical medical application of the discovery of the hormone, testosterone, that won a Nobel prize for its discoverers, is told in detail by this book. And thus another one of the mysterious hormones is brought into the service of mankind. The function of the male hormone and some of the research by leading endocrinologists are explained in nontechnical language.

Careers in Science. PHILIP POLLACK. 222 pp. Illus. 1945. $2.75. E. P. Dutton and Co., New York.

Here is a book to be given to that young person aspiring to be a scientist, but who is puzzled about which branch to select. Current facts about 15 different scientific fields and more than 70 different occupations in these fields are assembled into orderly fashion. Among the topics covered are opportunities for advancement, salary ranges and types of research done by universities, industrial firms and government agencies. A concluding chapter by Dr. Charles F. Kettering is packed with interesting research anecdotes.

* Orders for the books noticed above should not be sent to THE SCIENTIFIC MONTHLY or the A.A.A.S., but to your bookseller or the publisher.

MEET THE AUTHORS, Continued

JOHN MILLS, Director of Publication of the Bell Telephone Laboratories since 1925, was born in 1880 at Morgan Park, Illinois. He received his A.B. in 1901 from the University of Chicago, where he was a fellow in physics the following year. While a fellow at the University of Nebraska, he received his M.A. in 1904, and taught physics at Western Reserve University from 1903–07. After receiving the B.S. degree from the Massachusetts Institute of Technology in 1909, he was Professor of Physics and Electrical Engineering at Colorado College for two years. Taking a position in the Engineering Department, he served the American Telephone and Telegraph Company from 1911–15 and then spent the next six years in the Research Department of the Western Electric Company. After three years of personnel administration, Mr. Mills was appointed to his present position with Bell Telephone Laboratories. The author of more than ten books on technical subjects, his latest being *Electronics, Today and Tomorrow*, Mr. Mills is a fellow of the American Physical Society and the American Institute of Electrical Engineers. He invented several methods for wire and radio-telephony and conceived and supervised the design of Bell Telephone Exhibits at five World's Fairs.

EMILY EVELETH SNYDER, currently collaborating on a high school workbook to accompany *Biology and Man*, graduated from Tufts College in 1914. She assisted in the biology laboratory at Cornell while doing graduate work in entomology in 1918, but left her work on the M.A. degree to marry Vernon K. Snyder on his return from France. After his death in 1927, Mrs. Snyder returned to Little Falls, N. Y., to teach English and science. She began her writing career as editor and collaborator of various high school texts. Her *Biology in the Making* was published in 1940. A contributor of many articles on the history of science to THE SCIENTIFIC MONTHLY, *Frontiers*, and *The Teaching Biologist*, Mrs. Snyder has published some 50 poems and a number of articles in *Trails*, *American Weave*, *Lantern*, and other magazines and in newspapers. Her son, Marshall E., Tufts '42, is currently employed as a metallurgist in Detroit. Mrs. Snyder's hobbies are collecting ear rings and books on science.

IN 1772, William Herschel, music teacher of Bath and son of a Hanoverian bandmaster, borrowed a 2-ft. Gregorian telescope for some casual star-gazing. Fascinated by what he saw and unable to buy a telescope, he decided to make one.

Study of Smith's "Harmonies and Optics" and Ferguson's "Astronomy" and hard work casting and polishing specula resulted after several years in a 5-ft., a 7-ft. and even longer instruments.

HE DISCOVERED URANUS

Through his 7-ft. telescope, he discovered "Georgium Sidus" (Uranus) in 1781. Herschel carried figuring of his mirrors far beyond those of his predecessors and demonstrated the value of aperture to definition and grasp of light. Recognized as the link between the old and new astronomy, he won knighthood and the perpetuation of his name in the Herschelian "front view" telescope.

PURSUIT OF PERFECTION

Men of science like Herschel and his modern disciples have always set perfection as their goal. Working with such men in Industry, Education and the Armed Forces has been a challenge to Perkin-Elmer to supply them with the finest in optical instruments, lenses, prisms and other optical elements.

To the experience and skill that won recognition for Perkin-Elmer before the war has now been added the knowledge and experience gained in *mass-producing* its most accurate products for war industries and the armed forces. This combination promises much for the optical instruments, devices and elements which Perkin-Elmer will produce to bring even greater accuracy to analysis, control, inspection and observation in *postwar* applications.

WHAT PERKIN-ELMER MAKES

Perkin-Elmer serves the optical sciences that broaden man's horizons by supplying them with:

Custom-built optical instruments for industrial analysis, control, and inspection.

New optical devices to solve specific problems.

Special elements such as fine lenses, prisms, mirrors, flats, photographic objectives, interferometer plates, retardation plates, Cornu prisms, Rochon prisms, and Nicol prisms.

THE PERKIN-ELMER CORPORATION
GLENBROOK · CONN·

WITHOUT BALCOTE
Before the application of Balcote to a lens system in a camera or binocular, light striking the lens often obscured the scene. This picture was taken through a standard B&L uncoated lens. The best possible print was made from the negative thus secured.
WITH BALCOTE
A Balcote surfaced lens under identical conditions reveals the scene sharply, clearly, and with greater brilliance. This picture, taken through the same type B&L lens with Balcote finish, was given identical exposure and development. Note the detail and clarity in the print from this negative.

• *Valentino Sarra made the above two photographs with two cameras with simultaneous and equal exposure.*

"*Balcote*" Revolutionizes Optical Science

To build lens systems that would let more light through . . . that would eliminate the light loss and the "flare" caused by internal reflections . . . that would give sharper, clearer, more brilliant images . . . has been the objective of scientists for years.

Long before the war, Bausch & Lomb had developed methods of coating lenses to reduce reflections and permit the passage of more light. As a result, Bausch & Lomb, in 1939, introduced B&L Super Cinephor Projection Lenses with antireflection coatings. These lenses were used in projecting the Technicolor picture, "Gone With The Wind." They passed 30% more light, made possible the richer, deeper colors on a larger screen.

A further improvement of this same coating, today known as *Balcote* and recognized as among the best and most permanent available, is used on B&L Photographic Lenses, other military optical instruments, and wherever light transmission is a problem. Bausch & Lomb Optical Co., Rochester 2, N. Y.

BAUSCH & LOMB

ESTABLISHED 1853

MAKERS OF OPTICAL GLASS AND A COMPLETE LINE OF OPTICAL INSTRUMENTS FOR MILITARY USE, EDUCATION, RESEARCH, INDUSTRY, AND EYESIGHT CORRECTION AND CONSERVATION

Photography of Cathode Ray Tube Traces

The choice of a film for photographing cathode ray traces depends on the color of the light from the screen, the persistence time, and whether the trace is transient or stationary.

The Kodak Research Laboratories have recently completed tests of all Kodak materials under typical conditions of use of cathode ray tubes. Materials for a specific use can be selected on the basis of the data in the table shown below. Further details are given in a revised pamphlet on this subject. Copies are obtainable on request.

RELATIVE SPEEDS OF KODAK MATERIALS FOR CATHODE RAY PHOTOGRAPHY

Materials	*Transient Pattern (Blue Screen)*	*Stationary Pattern (Green Screen)*
Sheet Films		
Ortho-X	500	200
Tri-X Panchromatic	500	125
Super Panchro-Press, Sports Type	640	250
Roll Films and Packs		
Verichrome	320	80
Super-X Panchromatic	500	100
35-mm. Film		
Fluorographic	400	160
Super-XX Panchromatic	320	100

EASTMAN KODAK COMPANY

Research Laboratories **Rochester 4, N. Y.**

To those who wonder why we need still bigger War Loans

IN THE 7th War Loan, you're being asked to lend 7 billion dollars—4 billion in E Bonds alone.

That's the biggest quota for individuals to date.

Maybe you've wondered why, when we've apparently got the Nazis pretty well cleaned up, Uncle Sam asks you to lend more money than ever before.

If you have, here are some of the answers:

This war isn't getting any cheaper

No matter what happens to Germany—or when—the cost of the war won't decrease this year.

We're building up a whole new air force of jet-propelled planes and bigger bombers.

We're now building—even with announced reductions—enough new ships to make a fair-sized navy.

At the time this is written, our casualties are nearing the million mark in dead, missing, and wounded. Wounded men are arriving in this country at the rate of over 30,000 a month. The cost of caring for these men at the battle fronts, transporting them home, and rehabilitating them when they get here, is mounting daily.

No—this war isn't getting any cheaper. And won't for some time.

This year—2 instead of 3

We need as much War Bond money this year as we did last. But there will be only 2 War Loans this year—instead of the 3 we had in 1944.

Each of us, therefore, must lend as much in two chunks this year as we did last year in three. That's another reason why your quota in the 7th is bigger than before.

The 7th War Loan is a challenge to every American. The goal for individuals is the highest for any war loan to date. The same goes for the E Bond goal. Find your personal quota—and make it!

THE MIGHTY 7th WAR LOAN

ALL OUT FOR THE MIGHTY 7th WAR LOAN

American Association for the Advancement of Science
Smithsonian Institution Building
Washington 25, D. C.

This is an official U.S. Treasury advertisement—prepared under auspices of Treasury Department and War Advertising Council

AT RESEARCH FOUNDATION MICROMAX RECORDS PLASMA TEMPERATURES

Staff members of the Michael Reese Research Foundation, Chicago, sum up the performance of their Micromax Recorder in just one word—"trustworthy." A Micromax Recorder, with small thermocouples inserted right in the plasma jars, meets all the requirements this institution sets for measuring and recording the freezing and dry temperatures of blood plasma. The recorder is located near the two desiccators, so that the technician in charge of these machines can easily see actual plasma temperatures. If temperatures vary from the predetermined rate, the instrument operates automatic shut-off and alarm contacts.

Micromax Recorders combine high precision and delicate workmanship with rugged, machine-like construction. Measurements are made by the null-balance electrical method, working against the recorder's own standard of accuracy—a standard cell. Micromax sensitivity is that of a good pointer-type galvanometer; its accuracy that of high-grade electrical and mechanical components—its dependability that of a highly complete automatic machine.

There is a Micromax Recorder for most any need you may have—temperature, pH, conductivity of liquids, or gas analysis. When inquiring about Micromax, if you will be as specific as possible, we can usually send you a specific recommendation.

Micromax Recorder at the Michael Reese Research Foundation in Chicago gives a true temperature picture of blood plasma within desiccator #2.

V depends on me!
A Slogan For Every American

LEEDS & NORTHRUP COMPANY, 4945 STENTON AVE., PHILA. 44, PA.

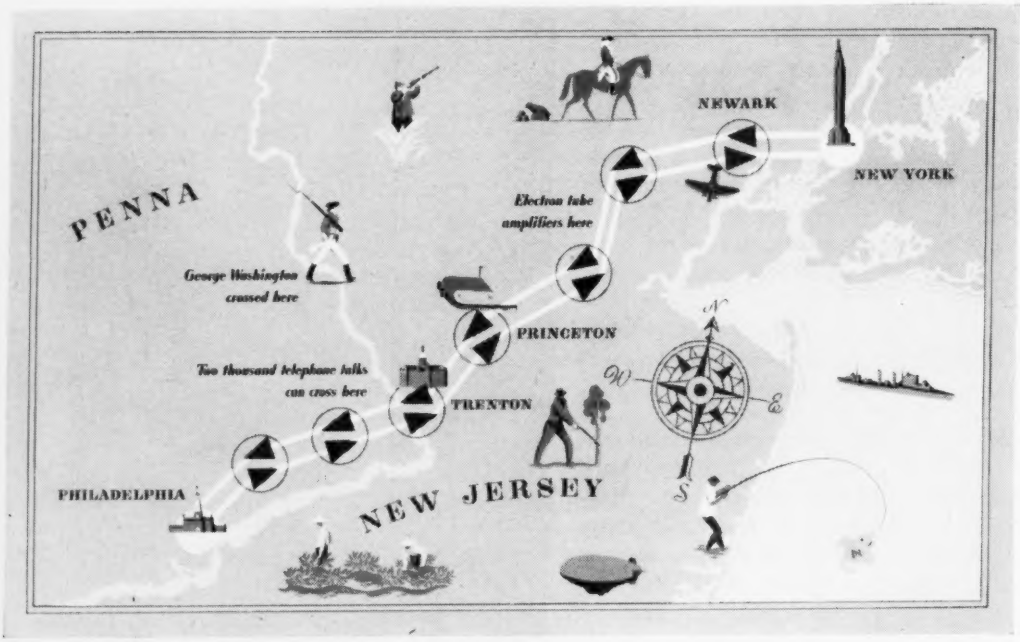
LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl Ad N-33A(23b)

90-MILE LABORATORY

for Telephone and Television



BETWEEN telephone offices in New York and Philadelphia once stretched a strange sort of laboratory. Most of the way it was underground; engineers made their measurements sometimes in manholes. It was a lead-sheathed cable containing two "coaxials"—each of them a wire supported in the center of a flexible copper tube the size of a lead pencil.

Theory had convinced Bell Laboratory engineers that a coaxial could carry many more telephone talks than a full-sized voice frequency telephone cable; that it could carry adequately a television program. Experimental lengths were tested; terminal apparatus was designed and tried out. Finally, a full-sized trial was made with a system designed for 480 conversations. It was successful; in one demonstration people talked over a 3800-mile circuit looped back and forth. Now the cable is carrying some of the wartime flood of telephone calls between the two cities.

This cable made television history also: through it in 1940 were brought spot news pictures of a political convention in Philadelphia to be broadcast from New York. Bell System contributions to television, which began with transmission from Washington to New York in 1927, have been laid aside for war work. When peace returns, a notable expansion of coaxial circuits is planned for both telephone and television in our Bell System work.

BELL TELEPHONE LABORATORIES *Exploring and inventing, devising and perfecting for our Armed Forces at war and for continued improvements and economies in telephone service.*

THE ECONOMETRIC SOCIETY

An international society for the advancement of economic theory in its relation to statistics and mathematics.

The Econometric Society was founded in 1930 and now has over 700 members in 40 countries. Its main object is to promote studies that aim at a unification of the theoretical-quantitative and the empirical-quantitative approach to economic problems and that are penetrated by constructive and rigorous thinking similar to that which has come to dominate in the natural sciences. The Society normally holds one or more meetings each year for the presentation and discussion of papers.

Econometrica, the quarterly journal of the Society, publishes reports of meetings and original papers in the field of quantitative economics. The subscription price is $7.00 per year to non-members.

Membership dues are $6.00 per year, including subscription to **Econometrica.**

Subscriptions to **Econometrica** and inquiries about the work of the Society and the procedure in applying for membership should be addressed to ALFRED COWLES, Secretary and Treasurer, The Econometric Society, The University of Chicago, Chicago 37, Illinois.

AMERICAN DAIRY SCIENCE ASSOCIATION

The American Dairy Science Association was organized in 1906 to stimulate scientific research in all phases of interest to the dairy industry and to dairy science, to improve methods of dairy instruction and extension work, to cooperate in educational developments in advancing the general welfare of the dairy industry, and to make available through the JOURNAL OF DAIRY SCIENCE the results of the latest scientific research pertaining to these fields.

Subscriptions are $6 per year. A person is eligible for membership when he is filling a position of responsibility connected with the dairy industry or having an interest in the dairy industry who has had college training in technical science. Affiliation fee for new members is $5 and membership dues are $5 per year, which includes subscription. The Journal is published monthly. The Secretary is R. B. STOLTZ, Ohio State University, Columbus 10, Ohio.

AMERICAN METEOROLOGICAL SOCIETY

The objects are the development and dissemination of knowledge of meteorology in all its phases and applications, and the advancement of its professional ideals. Membership is open to any persons whose interest or activity in meteorology would make them desirable members, and dues are $3.50. Professional Membership is open to those whose training and experience in meteorology meet the Society's standards for the professional level, and dues are $10. Corporation membership dues are $100.

The Bulletin is published 10 times a year; it is sent to all members and its subscription price to others is $3.50. Its some 40 pages per issue contain articles of general interest, reviews, notes, announcements, and classified abstracts of current meteorological literature.

The Journal of Meteorology is a quarterly devoted to the publication of research; it is sent to all Professional Members, its subscription price is $6 ($4 to members).

The Society meets twice or more times each year and its local branches weekly to monthly.

Complete information about the Society may be had by addressing the Secretary:

PROF. CHARLES F. BROOKS,
Blue Hill Observatory,
Milton 86, Mass.

Radiophoto—
news pictures out of the air!

RCA radiophoto transmits pictures halfway around the world and prints them—*in a matter of minutes!*

And thanks to RCA research, pictures now come through the receiver (shown above) about as sharp and clear as the originals themselves.

Through RCA radiophoto, today's "news shot" in Honolulu or Cairo can make tomorrow morning's front page.

Advertisements, fingerprints, documents and letters are radiophotoed by RCA Communications—as many as 2000 a month! Even musical scores—such as the new "Trio" by Shostakovich—are sent by faster, error-proof radiophoto.

RCA has long been a pioneer in all fields of international communications. Progress is constantly maintained by scientific research . . . research that is reflected in all RCA products.

When you buy an RCA radio, or any RCA product, you enjoy a special pride of ownership in knowing that you possess one of the finest instruments of its kind that science has yet achieved.

1945—London to New York—7 minutes

1926—New York to London—1½ hours

Notice the great improvement in clarity, as well as in speed. Because of RCA research, radiophoto prints are no longer blurred by a "pattern." They're about as clear as the original prints thousands of miles away.

RADIO CORPORATION of AMERICA

PIONEERS IN PROGRESS

RCA